Juru Energy

Bats Monitoring Report

ZARAFSHAN WIND FARM:

BAT MONITORING

CLIENT: TURNSTONE ECOLOGY

Date: December 2020

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This report was made by Denis Vasen'kov Ph. D. from A.N. Severtsov Institute of Ecology and Evolution, Moscow, Russia.

Wind farms can affect bats in the following ways:

I. Collision mortality, barotrauma and other injuries (although it is important to consider these in the context of other forms of anthropogenic mortality)
II. Loss or damage to commuting and foraging habitat, (wind farms may form barriers to commuting or seasonal movements, and can result in severance of foraging habitat);
III. Loss of, or damage to, roosts;
IV. Displacement of individuals or populations (due to wind farm construction or because bats avoid the wind farm area).

Bat surveys are required to quantify the impact of the project on key *Chiroptera* species to:

- inform final turbine layout;
- develop additional mitigation (*e.g*. turbine shut down, cutting speeds, habitat/species management plan); and
- form the baseline for any future required supplementary surveys and operational monitoring.

To ensure that bats are protected by minimising the risk of collision, an assessment of impact at a site requires a detailed appraisal of:

- The level of activity of all bat species recorded at the site assessed both spatially and temporally.
- The risk of turbine-related mortality for all bat species recorded at the site during bat activity surveys.
- The effect on the species' population status if predicted impacts are not mitigated.

The bat acoustic survey sampling effort is restricted to encompass 7 month warm season, extending from the beginning of April through the end of October, based on a lack of bat activity expected within the region during the colder months. It was proposed to conduct at least 5 complete nights of bat acoustic recording per location using Wildlife Acoustics Songmeter Minibat recorders, encompassing 29 locations spread throughout the Project area. We note that there is only a single species of bat occurring in Uzbekistan with an elevated conservation status according to IUCN, the Giant Noctule (*Nyctalus lasiopterus*, IUCN "Vulnerable"), and this species is unlikely to occur at the ZWEP site, as it is primarily a species of forested habitats, and primarily occurs to the west of the Caspian Sea[1]. Nonetheless, the risk of bat fatalities is typically a concern of international lenders, and bat acoustic surveys are typically recommended for wind-wildlife baseline surveys, as bat fatality rates are typically higher than bird fatality rates at wind energy facilities worldwide. As detectors were first installed only July 30, surveys for bats may need to resume in spring 2021 to fill in the gap in the active season.

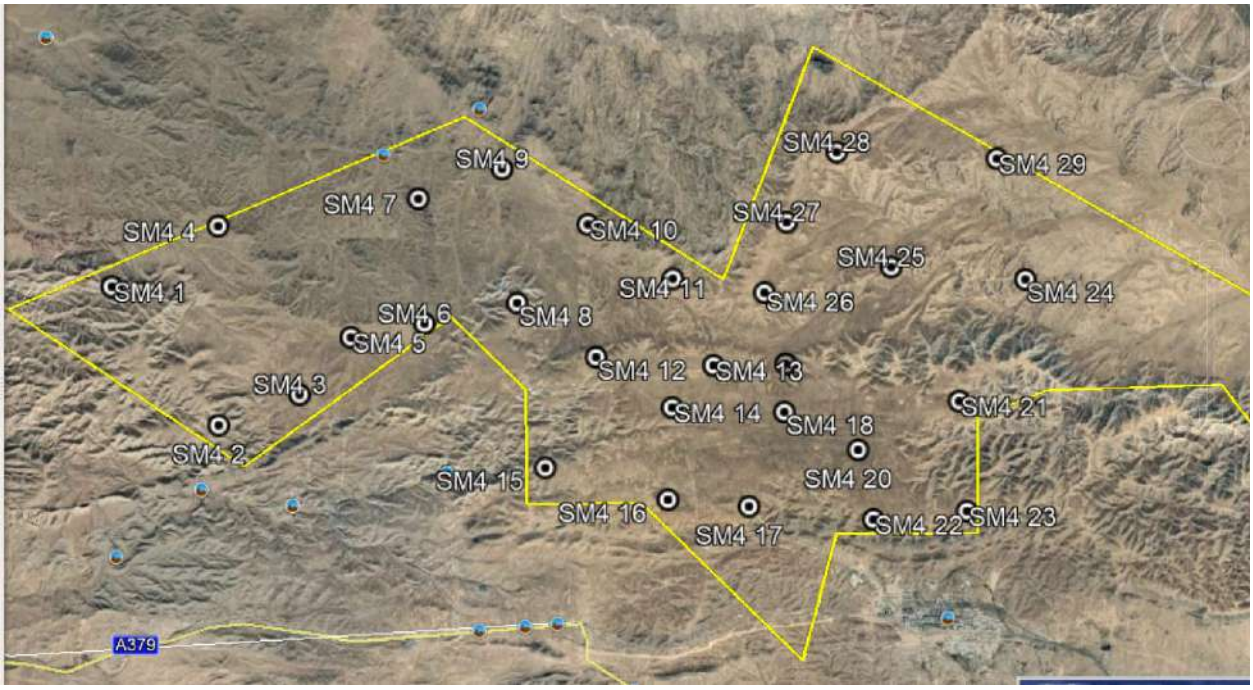

Fig. 1 Static bats detectors locations

In Autumn activity of bats has been monitored by three static bat detectors Wildlife Acoustics Song Meter SM4 since October 7 up to October 30 (and September 14). Usually the detectors were moved every five days between 10 locations in accordance with the schedule. The recordings were carried out over 43 nights. A total of 1741 files were recorded with a total volume of 7.75 GB.

According to the literature data on bats of Uzbekistan (Bogdanov, 1953; Benda et al., 2011; Gritsina et al., 2013) and semi-arid ecosystems, 9 species of bats are most likely to inhabit in Zarafshan: *Rhinolophus bocharicus, Eptesicus bottae, Eptesicus gobiensis, Eptesicus serotinus, Hypsugo savii, Myotis davidii, Nyctalus noctula, Pipistrellus pipistrellus, Vespertilio murinus.* Another 11 species known for Uzbekistan and neighboring countries may be found in Zarafshan also (Benda et al., 2011; Benda et al., 2012; Dietz, Kiefer, 2016): *Rhinolophus ferrumequinum, Rhinolophus hipposideros, Plecotus sp.*

[1] IUCN redlist of threatened species, accessed 27 March, 2020

(Gritsina et al., 2013), Myotis bucharensis, Myotis emarginatus, Myotis blythii, Myotis capaccinii, Barbastella caspica, Pipistrellus kuhlii, Otonycteris leucophaea, Tadarida teniotis.

Some of bat species inhabiting Uzbekistan are found in Europe also, and the parameters of ultrasonic calls are known for the European populations of these species (Barataud, 2015; Dietz, Kiefer, 2016). For some bats of Uzbekistan, the parameters of ultrasonic calls are not known. Determination of these species according ultrasonic calls is a complex process since manual identification is required. We used the Kaleidoscope Pro Auto Analysis program with "preloaded" parameters of ultrasonic calls from "European" bats found in Uzbekistan for the primary processing of audio recordings. We used the BatSound 4 program to measure the call parameters more accurately and identify the types of ultrasound calls (Barataud, 2015), which are not available in the Kaleidoscope Pro Auto Analysis database. We determined the bats species whose ultrasound calls were recorded.

Calls of 6 bats species were found in the study area (Table 1). These species are (in descending order of calls occurence): *Pipistrellus pipistrellus*, *Vespertilio murinus, Eptesicus serotinus*, *Eptesicus bottae*, *Nyctalus noctula*. CF-calls of horseshoe bats (Barataud, 2015) with Freak (Frequency of maximal energy) = 102 kHz were also detected. This is probably *Rhinolophus bocharicus*. This species is common in Uzbekistan, but absent in Europe, this is why the parameters of its ultrasonic calls are not known.

Table 1 Total occurrence of bat calls in all locations

Species	Occurrence of calls	Frequency of occurence, %
Pipistrellus pipistrellus	108	67,9
Vespertilio murinus	36	22,6
Eptesicus serotinus	11	6,9
Eptesicus bottae	2	1,3
Nyctalus noctula	1	0,6
Rhinolophus sp. (CF 102 kHz)	1	0,6
Total:	**159**	**100**

Bat calls were recorded at all locations (Table 2). No species were recorded in all the 10 locations. Calls of the largest number of species (four species on each point) were recorded at the extreme western (No. 1) and eastern (No. 25) locations. The number of locations of the registered calls of every species correlates with the total number of registered calls of this species. The largest number of calls were recorded from *Pipistrellus pipistrellus*, and its signals were recorded at the largest number of locations (80%). Calls from *Nyctalus noctula* and *Rhinolophus* sp. are the rarest (they occurred one time only).

Ultrasound calls of bats included in IUCN or the Red Book of the Republic of Uzbekistan were not found (The Red Book of the Republic of Uzbekistan, 2019).

Table 2 Occurrence of bat calls on various locations

Species	**Location №**											**Place of registration, %**
	1	5	8	9	13	18	19	20	25	26	**All**	
Pipistrellus pipistrellus	1	1	1	0	2	**4**	1	0	**89**	**9**	**108**	**80**
Vespertilio murinus	**3**	1	**2**	**16**	2	0	0	0	8	4	**36**	70
Eptesicus serotinus	1	1	0	0	0	2	**2**	**1**	0	4	**11**	60
Eptesicus bottae	0	0	0	0	0	1	0	0	1	0	**2**	20
Nyctalus noctula	1	0	0	0	0	0	0	0	0	0	**1**	10
Rhinolophus sp. (CF 102 kHz)	0	0	0	0	0	0	0	0	1	0	**1**	10
Total:	**6**	**3**	**3**	**16**	**4**	**7**	**3**	**1**	**99**	**17**	**159**	
Dates (October):	15-19	20-23	24-27	28-30	13-14	13-16	17-18	7-13	19-22	14-19 (and 14.09. 2020)		

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Juru Energy

Spring-Summer Bats Monitoring Report

ZARAFSHAN WIND FARM:

BIRD AND BAT MONITORING

CLIENT: WOOD GROUP

Date: 2021

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Contents

Introduction 3

Materials and methods 4

Bat calls identification 4

Results 8

References.....123

Attachments.....134

Introduction

Wind farms can affect bats in the following ways:

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II. Loss or damage to commuting and foraging habitat, (wind farms may form barriers to commuting or seasonal movements, and can result in severance of foraging habitat);
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[1] IUCN redlist of threatened species, accessed 27 March, 2020

Materials and methods

Study area and bat calls recording

We used two the static bat detectors Wildlife Acoustics Song Meter SM4 to monitor bats activity in Spring and Summer at 13 locations within the project's area (Tabl. 1, Fig. 1S in Attachments). The mobile detector was used to record bat calls on mobile transects for three nights on May 18-20 (Fig. 1S and Table S in Attachments).

Table 1. Detector locations

№ location	Location name	Work days	Coordinates	
			°N	°E
1	2-5	1-10 April	41°35'17.65"	64°18'21.13"
2	2-6	11-14 April	41°35'0.45"	64°23'18.16"
3	2-7	15-19 April	41°33'34.17"	64°25'21.61"
4	2-8	20-23 April	41°34'16.71"	64°27'11.63"
5	2-9	9-23 May	41°33'4.80"	64°28'2.35"
6	2-10	24 May – 8 June	41°32'16.88"	64°25'42.08"
7	2-1*	9-14 June	41°37'24.20"C	64°28'4.47"
8	2-2	15-23 June	41°37'27.94"	64°31'17.01"
9	2-3	24-25 June	41°37'38.25"	64°31'46.63"
10	2-4	26 June - 12 July	41°36'1.61"	64°32'45.52"
11	5-5	6-24 June	41°34'59.59"	64°19'12.28"
12	5-6	25 June	41°33'21.28"	64°27'2.89"
13	5-7	26-27 June	41°32'56.53"	64°29'52.25"

*** -** there are no recordings of the static detector on the location (2-1) for technical reasons. Therefore, it is excluded from the analysis.

One detector (No. 2) recorded data from April 1 to July 12 at ten locations from 18:00 to 6:00 every night (exclude April 24 – May 8). Second detector (№5) recorded data on June 6-27 from 18:00 to 6:00 every night. Usually, the detector worked at one location for several nights (from 4 to 19 nights) before it was moved to another location (Tabl. 1). The detectors worked for less than three days (2-3, 5-6 and 5-7) in only three locations. Unfortunately, there are no recordings of the static detector on the location (2-1) for technical reasons. It is excluded from the analysis. So only 12 locations were used to analyze activity of bats.

Audio recordings of the transects were recorded at 85 locations over three nights May 18-20 (Table 1S in the Attachments). The recording of ultrasonic calls at each location was carried out for 5-8 minutes.

Bat calls identification

According to the literature data on bats of Uzbekistan (Bogdanov, 1953; Benda et al., 2011; Gritsina et al., 2013) and semi-arid ecosystems, 9 species of bats are most likely to inhabit Zarafshan project area (Tabl. 2): *Rhinolophus bocharicus, Eptesicus bottae, Eptesicus gobiensis, Eptesicus serotinus, Hypsugo savii, Myotis davidii, Nyctalus noctula, Pipistrellus pipistrellus, Vespertilio murinus.*

Table 2. Species that were more likely to be found in the vicinity of Zarafshan (semi-arid ecosystems).

Species	IUCN Red List	Red Book of the Republic of Uzbekistan (2019)	Parameters of ultrasound calls (references)	Basic flight information (flight height; presence of migrations)	Level of collision risk (Rodrigues et al., 2015)
Rhinolophus bocharicus	LC (Least concern)	absent	no data (CF-type calls)	Most likely, *R. bocharicus* is a sedentary species, foraging low from the ground (like other horseshoe bats (Bogdanov, 1953; Rodrigues et al., 2015)).	low
Eptesicus bottae	LC	absent	Benda et al. (2012); Hackett et al. (2016)	*E. bottae* ranks among small- to medium-sized bats hunting its prey mostly in a slow hawking flight (Benda et al., 2012); probably sedentary.	medium
Eptesicus gobiensis	LC	absent	no data	no data	medium
Eptesicus serotinus	LC	absent	Benda et al. (2012)	Medium height (Roemer et al., 2017); usually sedentary (Dietz, Kiefer, 2016)	medium
Hypsugo savii	LC	absent	Benda et al. (2012)	Medium height (Roemer et al., 2017); no data on migration (Dietz, Kiefer, 2016)	high
Myotis davidii	LC	absent	no data	Low height (Roemer et al., 2017); probably sedentary	low
Nyctalus noctula	LC	absent	Barataud (2015)	High height (Roemer et al., 2017); migrate (Dietz, Kiefer, 2016)	high
Pipistrellus pipistrellus	LC	absent	Benda et al. (2012)	Medium height (Roemer et al., 2017; Wellig et al., 2018); sedentary (Bogdanov, 1953; Dietz, Kiefer, 2016)	high
Vespertilio murinus	LC	absent	Barataud (2015)	High height (Roemer et al., 2017); usually migrate (Dietz, Kiefer, 2016)	high

Another 11 species known for Uzbekistan and neighboring countries (Tabl. 3) may be found in Zarafshan also (Benda et al., 2011; Benda et al., 2012; Dietz, Kiefer, 2016): *Rhinolophus ferrumequinum, Rhinolophus hipposideros, Plecotus sp.* (Gritsina et al.,

2013), *Myotis bucharensis, Myotis emarginatus, Myotis blythii, Myotis capaccinii, Barbastella caspica, Pipistrellus kuhlii, Otonycteris leucophaea*[2], *Tadarida teniotis.*

Table 3. The bat species that inhabiting in Uzbekistan and neighboring countries and can be found in the vicinity of Zarafshan.

Species	IUCN Red List	Red Book of the Republic of Uzbekistan (2019)	Parameters of ultrasound calls	Basic flight information (flight height; presence of migrations)	Level of collision risk (Rodrigues et al., 2015)
Rhinolophus ferrumequinum	LC	absent	Benda et al. (2012)	Low height (Roemer et al., 2017); sedentary (Dietz, Kiefer, 2016)	low
Rhinolophus hipposideros	LC	Vulnerable, declining 2(VU:D)	Benda et al. (2012)	Low height (Roemer et al., 2017); sedentary (Dietz, Kiefer, 2016)	low
Plecotus sp. (Gritsina et al., 2013)	?	absent	Barataud (2015), Benda et al. (2012)	Low height (Roemer et al., 2017); sedentary	low
Myotis bucharensis	DD (data deficient)	Critically Endangered 1(CR)	no data	Low height (Roemer et al., 2017); probably sedentary	low
Myotis emarginatus	LC	absent	Barataud (2015)	Low height (Roemer et al., 2017); sedentary (Dietz, Kiefer, 2016)	low
Myotis blythii	LC	absent	Benda et al. (2012)	Low height (Wellig et al., 2018); sedentary (Dietz, Kiefer, 2016)	low
Myotis capaccinii (?)	VU (vulnerable)	absent	Benda et al. (2012)	Low height; short to middle-range migrant (Dietz, Kiefer, 2016)	low
Barbastella caspica (Barbastella leucomelas)	LC	absent	Benda et al. (2012); Hackett et al. (2016)	Probably low height; probably sedentary	medium
Pipistrellus kuhlii	LC	absent	Benda et al. (2012)	Low height (Roemer et al., 2017); sedentary (Dietz, Kiefer, 2016)	high
Otonycteris leucophaea	DD	Vulnerable, naturally rare 2(VU:R)	no data	Low height (Benda et al., 2012), probably sedentary	unknown
Tadarida	LC	Vulnerable,	Benda et	High height (Wellig et al.,	high

[2] *Otonycteris hemprichi* does not inhabit Uzbekistan (Benda et al., 2011). It was indicated for Uzbekistan in the 20th century (Bogdanov, 1953), when the species *Otonycteris hemprichi* and *Otonycteris leucophaea* were not distinguished. Only *Otonycteris leucophaea* lives in Uzbekistan according to the modern concepts of taxonomists. From a formal point of view, this is a different species. Most likely, the authors of the essays in the Red Book of Uzbekistan (2019), have not being familiar with modern data (for example, Benda et al., 2011), and wrote down an "outdated" name that currently refers to other animals found, for example, in Iran (Benda et al., 2012). Both of these species are found in Iran.

teniotis		naturally rare 2(VU:R)	al. (2012)	2018); no seasonal migration, foraging area up to 100 km distant from summer roost (Dietz, Kiefer, 2016)	

Some of bat species inhabiting Uzbekistan are found in Europe also, and the parameters of ultrasound calls are known for the European populations of these species (Barataud, 2015; Dietz, Kiefer, 2016). For some bats of Uzbekistan, the parameters of ultrasonic calls are not known (Tabl. 2, 3). Determination of these species according ultrasonic calls is a complex process since manual identification is required.

Identification of bats from the acoustic recordings gathered during this study was performed by Dr. Denis Vasenkov, a professional bat biologist affiliated with the A. N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences. Dr. Vasenkov's experience includes studying bats for about 20 years, including 10 years working with time expansion and real-time bat detectors. Dr. Vasenkov worked with bats and their ultrasonic calls from various regions of Russia (European and Asian parts), Ethiopia and Vietnam. Dr. Vasenkov has experience in analyzing bats ultrasound calls using ***BatSound***, ***SonoBat*** and ***Kaleidoscope*** software. We used the Kaleidoscope Pro Auto Analysis program with "preloaded" parameters of ultrasonic calls from "European" bats found in Uzbekistan for the primary processing of audio recordings. After that, we used the BatSound 4 program to measure the call parameters and check the identification of bat calls made by the Kaleidoscope Pro Auto Analysis program. We used bat calls parameters known for European bat populations (Barataud, 2015) and bat species from neighboring countries for Uzbekistan (Benda et al., 2012).

Additionally, we used bat calls parameters of *Rhinolophus bocharicus* and *Eptesicus bottae* recorded our colleagues during fieldwork (Gritsina, unpubl.). Colleagues searched for bats' shelters in the vicinity and on the territory of Zarafshan Wind Farm in the spring and summer of 2021 (Gritsina, Abduraupov, unpubl.). Three species of bats, the Bokhara horseshoe bat (*Rhinolophus bocharicus*), the Ognev's serotine bat (*Eptesicus bottae*) and the Common pipistrelle bat (*Pipistrellus pipistrellus*), have been found as a result of these fieldwork.

Because the "border" between *Eptesicus serotinus* and *Eptesicus bottae* is unknown; we identified their signals only up to the genus level (*Eptesicus* sp.).

We identified bat calls to species whenever it was possible (the term "bat call" refers to one file with any bat species calls). After that, for all bat calls we calculated "Relative abundance", "Frequency of occurrence" and acoustic activity index (AI). Relative abundance is the frequency at which calls of some species are recorded among all types of calls (excluding noise, social calls and unidentified calls).

Acoustic activity index (AI) is the average number of calls registered on one location for one day of monitoring. We used data of ultrasound detectors to calculate the "Relative abundance" and acoustic activity index (AI) (Table 4).

Results

The detectors recorded 5990 files (20.1 GB) during the entire operation period. Most of the files contained noises, not bats ultrasound calls. Therefore, an automatic filtering of calls from noise was carried out. Noisy files were excluded from work. Bat calls were recorded in 12 of the 13 locations where static detectors were installed (Table 4). Most likely, the absence of bat calls in one of the locations (2-1) is due to technical problems in the operation of the detector. Bat calls on transects were detected in only 17 locations from 85 (Fig. 1, Table 1S in Attachments).

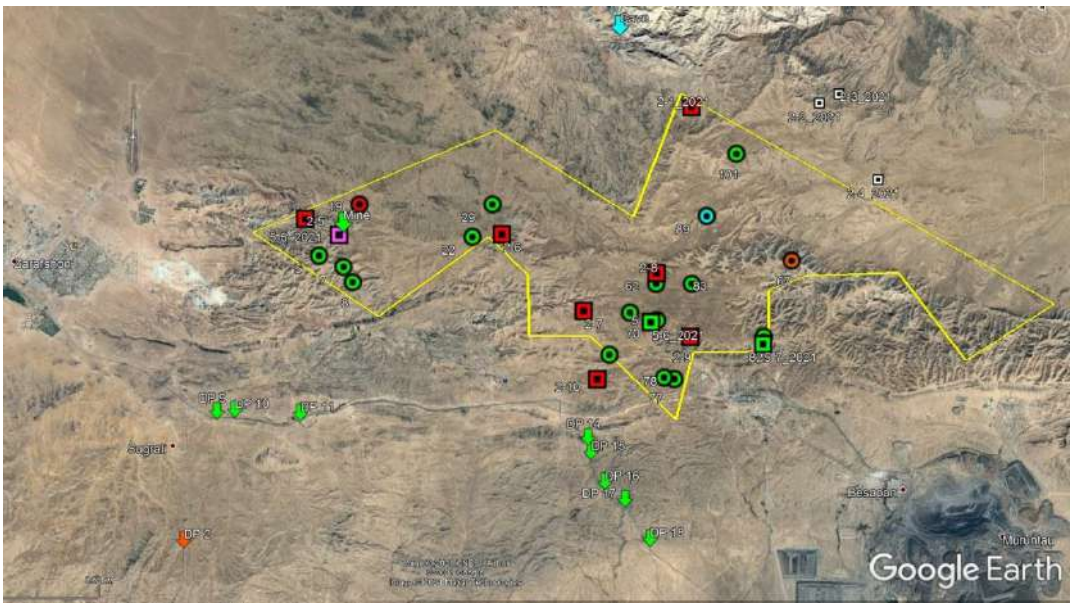

Fig. 1. Locations with recordings of bats. Legend: squares - stationary detectors, circles - locations on the transect; location color: green – *Eptesicus sp*. (*Eptesicus bottae* + *Eptesicus serotinus*), red – *Eptesicus sp*. and *Pipistrellus pipistrellus*, blue – *Rhinolophus bocharicus*, purple - *Eptesicus sp*., *P. pipistrellus* and *R. bocharicus*. Arrows are bats shelters according to survey data (Gritsyna, Abduraupov, unpubl.).

Bats activity by static detectors

The activity of bats varied greatly in different locations. The highest level of activity was recorded in central locations (Tab. 4, Fig. 1). The highest level of bats activity (AI=77,8) was recorded at location 2-7 on April 15-19. The lowest level of bats activity (4.8) in the central part of the park was noted on May 24 - June 8 at location 2-10, located 900 m from the park border. In the rest of the park, the activity level was relatively low and ranged from AI = 2.6 at location 2-6 to AI = 14 at location 5-5.

The species composition of bats includes 3-4 species of bats: *Eptesicus sp*. (*Eptesicus bottae* + *Eptesicus serotinus*), *Pipistrellus pipistrellus* and *Rhinolophus bocharicus. Eptesicus sp*. – this is the most common species on the territory of the wind farm. *Pipistrellus pipistrellus* is less common. Calls of the *Rhinolophus bocharicus* were the most rare.

Table 4. Bats Activity Based on Static Detector Data

Species	№ locations													Relative abundance, %	Frequency of occurrence, %
	2-5	2-6	2-7	2-8	2-9	2-10	2-2	2-3	2-4	5-5	5-6	5-7	**All**		
Eptesicus sp. (E. serotinus + E. bottae)	43	12	134	184	255	64	92	9	62	260	21	33	**1169**	63,2	83,3
Pipistrellus pipistrellus	9	1	255	23	367	2	0	1	19	2	0	0	**679**	36,7	66,7
Rhinolophus sp. (CF 102 kHz)	0	0	0	0	0	0	0	0	0	2	0	0	**2**	0,1	8,3
Total:	**52**	**13**	**389**	**207**	**622**	**66**	**92**	**10**	**81**	**264**	**21**	**33**	**1850**		
Nights of work:	10	4	5	4	15	16	9	2	17	19	1	2	104		
AI	5,2	3,3	77,8	52	41	4,13	10	5	4,8	14	21	16,5	17,8		

Bats activity on transects

The species composition of bats according to the survey data on transects includes 3-4 species of bats: *Eptesicus sp.* (*Eptesicus bottae* + *Eptesicus serotinus*), *Pipistrellus pipistrellus* and *Rhinolophus bocharicus*. Calls of Eptesicus sp. were most often registered on the territory of the wind farm (in 16 locations out of 17). Calls of other species were recorded much less frequently. *P. pipistrellus* signals were recorded in 2 locations, and *R. bocharicus* - in 1 location out of 17.

Discussion and recommendations

Ultrasonic calls of 3-4 species of bats were found in the project area. The habitation of 3 species (*Eptesicus bottae*, *P. pipistrellus and R. bocharicus*) was confirmed by field studies during the search for bats' shelters (Gritsina, Abduraupov, unpubl.).

All bat species, which calls were detected on the project area, are classified as LC ("Least concern", IUCN) and are not considered threatened. The Red Book of the Republic of Uzbekistan (2019) include four bat species: *Rhinolophus hipposideros* (VU), *Tadarida teniotis* (VU), *Otonycteris hemprichi* (VU)[3], *Myotis bucharensis* (CE). The fact that none of these listed species was detected during the acoustic monitoring effort provides an indication that the Project is not likely to generate impacts to any protected species of bats.

But bats, whose calls have been recorded at the site, have a risk of collision with the wind turbine. Low-flying species *Rhinolophus bocharicus* have the lowest risk of such a collision (Tabl. 2). *Rhinolophus bocharicus* has the least threat from wind turbines compared to other found species, because, most likely, it hunts from perches at a low height, like other species of the genus (Rodrigues et al., 2015). There is some risk of injury to other found bat species from wind turbines, because they can use high height for feeding and transit flights.

The two medium-flying species of the genus *Eptesicus* (63.2% relative abundance) have the medium risk of collisions (Roemer et al., 2017). Another species with a medium risk of collision with wind turbines is *P. pipistrellus* (Roemer et al., 2017; Wellig et al., 2018). The abundance of its calls is 36.7%.

But the data obtained in 2021 indicate large fluctuations in bats activity in the project area, from 3.3 to 77,8 bat calls per night. The highest activity level of bats was recorded in the southern half of the central part of the wind farm. The nearest discovered bats shelters are located 2.5 km south of this site (Fig. 1, Gritsyna, Abduraupov, unpubl.). In addition, the mine to the west of the site (Fig. 1, Gritsyna, Abduraupov, unpubl.) is also a refuge for *Eptesicus bottae*. Bats from nearby human settlements (Besapan, Zarafshon et al.) Can also use the proposed wind farm for feeding and transit flights. Wind turbines in the southern half of the central part of the wind farm may pose the greatest risk to bats. It is recommended to avoid installing wind turbines in this part of the wind farm. The potential negative impact of wind turbines on bats (death from collisions, barotrauma) in the project area can be minimized if use automated ultrasonic detectors to estimate the activity and identity of bats in the zone of highest mortality risk at wind turbine in order to formulate mitigation schemes, such as increased curtailment

[3] *Otonycteris hemprichi* does not inhabit Uzbekistan (Benda et al., 2011). It was indicated for Uzbekistan in the 20th century (Bogdanov, 1953), when the species *Otonycteris hemprichi* and *Otonycteris leucophaea* were not distinguished. Only *Otonycteris leucophaea* lives in Uzbekistan according to the modern concepts of taxonomists. From a formal point of view, this is a different species. Most likely, the authors of the essays in the Red Book of Uzbekistan (2019), have not being familiar with modern data (for example, Benda et al., 2011), and wrote down an "outdated" name that currently refers to other animals found, for example, in Iran (Benda et al., 2012). Both of these species are found in Iran.

speeds to prevent casualties (Voigt et al., 2021). The economic damage from such stops will be minimal, because high bats activity in the project area most likely occurs at nights with low wind speed, when the efficiency of power generation is low (Arnett et al., 2011). As known, increase of the cut-in wind speed and / or feathering of blades during low wind speed conditions reduces bat mortality (Arnett et al., 2011). Cut-in wind speed and / or feathering of blades can be especially important in days when a high activity of bats is registered. This will prevent massive death of bats and the associated risks of "environmental" damage.

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Attachments

Fig. 1S. Locations of bat detectors (13 for static detectors (yellow squares) and 85 - locations on the transects (white circles))

Table 2S. Locations on mobile transect.

№ location	Date	Start of record	°N	°E	Number
76	18.05.2021	21:48	41,538419	64,447419	1
77	18.05.2021	22:12	41,538584	64,456292	2
78	18.05.2021	22:38	41,538072	64,460605	3
75	18.05.2021	22:54	41,542781	64,440248	4
74	18.05.2021	23:03	41,545747	64,433438	5
51	18.05.2021	23:18	41,558924	64,442087	6
70	18.05.2021	23:30	41,556511	64,453462	7
71	18.05.2021	23:40	41,555361	64,462170	8
72	18.05.2021	23:50	41,551724	64,472215	9
73	18.05.2021	23:58	41,549570	64,477190	10
80	19.05.2021	1:05	41,548836	64,483840	11
81	19.05.2021	0:14	41,549632	64,491645	12
82	19.05.2021	0:22	41,551335	64,498161	13
50	19.05.2021	0:47	41,558285	64,434842	14
58	19.05.2021	1:00	41,573158	64,443304	15
59	19.05.2021	1:11	41,572672	64,450382	16
62	19.05.2021	1:20	41,567910	64,453021	17
83	19.05.2021	1:36	41,567946	64,467966	18
60	19.05.2021	1:45	41,573658	64,462866	19
61	19.05.2021	1:59	41,574882	64,473497	20
84	19.05.2021	2:20	41,566723	64,478349	21
63	19.05.2021	2:31	41,575038	64,481057	22

86	19.05.2021	2:53	41,567174	64,492259	23
85	19.05.2021	3:03	41,565246	64,497791	24
64	19.05.2021	3:20	41,573782	64,489724	25
65	19.05.2021	3:30	41,577531	64,498809	26
66	19.05.2021	3:39	41,574588	64,503849	27
67	19.05.2021	3:49	41,575194	64,509896	28
79	19.05.2021	4:25	41,585940	64,449683	29
87	19.05.2021	4:34	41,585906	64,455872	30
88	19.05.2021	4:43	41,588373	64,464494	31
89	19.05.2021	4:50	41,589176	64,474278	32
5	19.05.2021	19:53	41,576694	64,311691	33
6	19.05.2021	20:20	41,573078	64,313449	34
7	19.05.2021	20:30	41,573201	64,321927	35
8	19.05.2021	20:42	41,568410	64,325843	36
15	19.05.2021	21:10	41,582382	64,342965	37
21	19.05.2021	21:18	41,587743	64,336105	38
20	19.05.2021	21:26	41,590135	64,331538	39
19	19.05.2021	21:33	41,592802	64,328590	40
16	19.05.2021	21:44	41,578853	64,346627	41
36	19.05.2021	21:57	41,566839	64,349802	42
35	19.05.2021	22:05	41,571694	64,347527	43
17	19.05.2021	22:23	41,577183	64,358383	44
18	19.05.2021	22:31	41,572755	64,361133	45
47	19.05.2021	22:41	41,581490	64,367019	46
24	19.05.2021	22:49	41,587590	64,365183	47
22	19.05.2021	23:04	41,582648	64,376000	48
23	19.05.2021	23:13	41,583686	64,384455	49
30	19.05.2021	23:22	41,589064	64,389238	50
29	19.05.2021	23:32	41,592865	64,384391	51
28	19.05.2021	23:42	41,598164	64,379360	52
37	20.05.2021	0:00	41,611087	64,391939	53
38	20.05.2021	0:11	41,608931	64,398273	54
39	20.05.2021	0:27	41,605900	64,402451	55
41	20.05.2021	0:42	41,600239	64,413092	56
42	20.05.2021	0:51	41,596899	64,418803	57
43	20.05.2021	1:01	41,593527	64,424164	58
44	20.05.2021	1:10	41,591243	64,430377	59
45	20.05.2021	1:20	41,586519	64,437243	60
46	20.05.2021	1:34	41,586199	64,443414	61
95	20.05.2021	1:45	41,599156	64,455870	62
97	20.05.2021	1:56	41,610389	64,464284	63
96	20.05.2021	2:06	41,610900	64,458817	64
98	20.05.2021	2:22	41,609554	64,470373	65
99	20.05.2021	2:34	41,607495	64,475703	66
100	20.05.2021	2:44	41,607693	64,482740	67
101	20.05.2021	2:51	41,608691	64,486746	68
89	20.05.2021	3:18	41,589176	64,474278	69
90	20.05.2021	3:27	41,591066	64,482731	70

92	20.05.2021	3:39	41,589524	64,498149	71
93	20.05.2021	3:47	41,588657	64,503851	72
94	20.05.2021	3:57	41,589166	64,509626	73
91	20.05.2021	4:14	41,592996	64,492998	74
57	20.05.2021	4:36	41,573639	64,437221	75
56	20.05.2021	4:50	41,574698	64,431043	76
55	20.05.2021	4:57	41,575927	64,424953	77
54	20.05.2021	5:05	41,574542	64,414571	78
48	20.05.2021	5:12	41,572331	64,407530	79
34	20.05.2021	5:21	41,574227	64,399799	80
31	20.05.2021	5:41	41,586310	64,394486	81
49	20.05.2021	20:13	41,560840	64,427180	82
69	20.05.2021	20:26	41,555026	64,416532	83
53	20.05.2021	21:06	41,556122	64,408725	84
52	20.05.2021	21:22	41,557021	64,400783	85

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BAT ROOST SEARCH
OF THE RESIDUAL MOUNTAINS OF TAMDYTAU
(NAVOI REGION, KYZYLKUM DESERT)
IN APRIL

ZARAFSHAN WIND FARM PROJECT:
CLIENT: WOOD GROUP
Date: May 2021

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Contents

INTRODUCTION 3
1. MATERIALS AND METHODS 3
2. GEOGRAPHICAL FEATURES OF THE STUDIED AREA 4
3. RESULTS 5
CONCLUSIONS 15
RECOMMENDATIONS 16
References (SOURCES OF INFORMATION USED IN PREPARING THE REPORT) 16
Appendix 1. Additional photographic material 17

INTRODUCTION

The *Chiroptera* order, is the least studied order on the territory of the Republic of Uzbekistan, and the most numerous of the mammals, with the exception of Rodents. Poorly studied, especially in remote desert areas.

This report contains the results of the survey in the Tamdytau in the period from 15 to 17 April 2021. The aim of the survey was to determinate the presence/absence of Bats in potential shelters identified as a result of the processing of topographic and literary material. In case of a bat detected, it was planned to determine it the species, record their number and reproductive status (breeding / non-breeding individuals), the presence of brood colonies. In addition to measuring and photographing the detected species, it was planned to use mobile bat detectors to make "reference" recordings of ultrasonic (ultrasonic) signals for species identified. These "reference" signals will b e used in the future for further decoding of audio recordings of static bat detectors from project sites and transects, since some species of bats of Uzbekistan are absent in Europe and the parameters of ultrasonic signals are not known for them.

1. MATERIALS AND METHODS

The methods were divided into two stages:

Desktop preparation for the survey, included the analysis of detailed topographic maps of the area (scale: 1:100 000, 1:200 000) and Google Earth satellite images. The maps identified the locations (GPS coordinates) of potential bat shelters – caves, mines, human buildings, wells, burial grounds and were transferred to the LocusPro program for further use in the field. A total of 20 locations were identified for the survey at this stage.

Field work included a survey of potential shelters selected during the desktop analysis. Rock outcrops with crevices and caves were identified on the spot. When a shelter was found, it was carefully examined, both for the presence of bats themselves, and for indirect signs of their presence – excrement, food remains (insect wings, legs, etc.).

Each surveyed site was mapped, photographed, briefly described, including the degree to which it was suitable for bats as either a temporary or permanent refuge, the potential degree of disturbance/threat was recorded, and the height, width and length were measured where necessary.

195 km of the route was covered and information was collected on 25 potential shelters.

Equipment

To navigate the terrain and record tracks, a smartphone (MIUI REDME 3) was used with the installed LocusPro program, Google Hybrid map substrates, and Marshruty.ru. Two Nikon Aculon 10x42 and Nikon Prostaff 7S 10x42 binoculars were used to survey the area.

To survey the shelters, each surveyor was equipped with the following equipment: flashlight (Fenix HP30R) (2), cloth bags (2), disposable rubber gloves (2), thick rubber gloves (2), tweezers (2), forceps (2), ruler (2), meter (2).

All information obtained was recorded in a notebook using a pencil or pen.

2. GEOGRAPHICAL FEATURES OF THE STUDIED AREA

Tamdytau is located in the Kyzylkum physical-geographical region. It is placed in the center of the plain part of Central Asia, which is associated with desert landscape. This physiographic area includes the western part that belongs to Uzbekistan and the Kyzylkum desert, while its northern and eastern parts are in Kazakhstan. It borders with Kazakhstan to the north, with Turkmenistan to the southwest, with Mirzachul region to the east, with Zarafshan to the southeast and with the Zarafshan region in the west. The surface of the area in the direction from southeast to north-west slightly decreases. The average height is 200-300 m, in the southeast the height reaches 350-400 m, in the north-west-only 100 m.

The lowest point is the Mingbulak Depression, 12 m below sea level. The highest point is Aktau peak (height 922 m) of Tamdytau mountain. The relief of the Kyzylkum region is diverse.

There are plains, remnant mountains and depressions located between the mountains. However, most of Kyzylkum consists of plains with an absolute height of up to 200 m. The main part of the plain is occupied by sand ridges, sand hills, dunes, takyrs. Dunes are found mainly on the banks of the Amu Darya and around wells. Sand ridges and hills are fixed by plants. The inter-ridge depressions are occupied by takyrs. Autumn in Kyzylkum is mostly dry. The annual precipitation is small (up to 75-100 mm), and it is distributed unevenly over the seasons. The main part of the annual precipitation falls in the spring (up to 48%) and winter (up to 30%), but evaporation reaches up to 1000-1500 mm.

There are no permanent watercourses in Kyzylkum. Only the Amu Darya River passes through the southwestern part of the area. However, in the spring, as a result of rains and snow melt, temporary flows form on the slopes of low mountains, which quickly dry up. In the strata of Mesozoic and Paleogene sediments, there are fresh artesian waters. Mineral thermal waters have also been found in Paleozoic sediments.

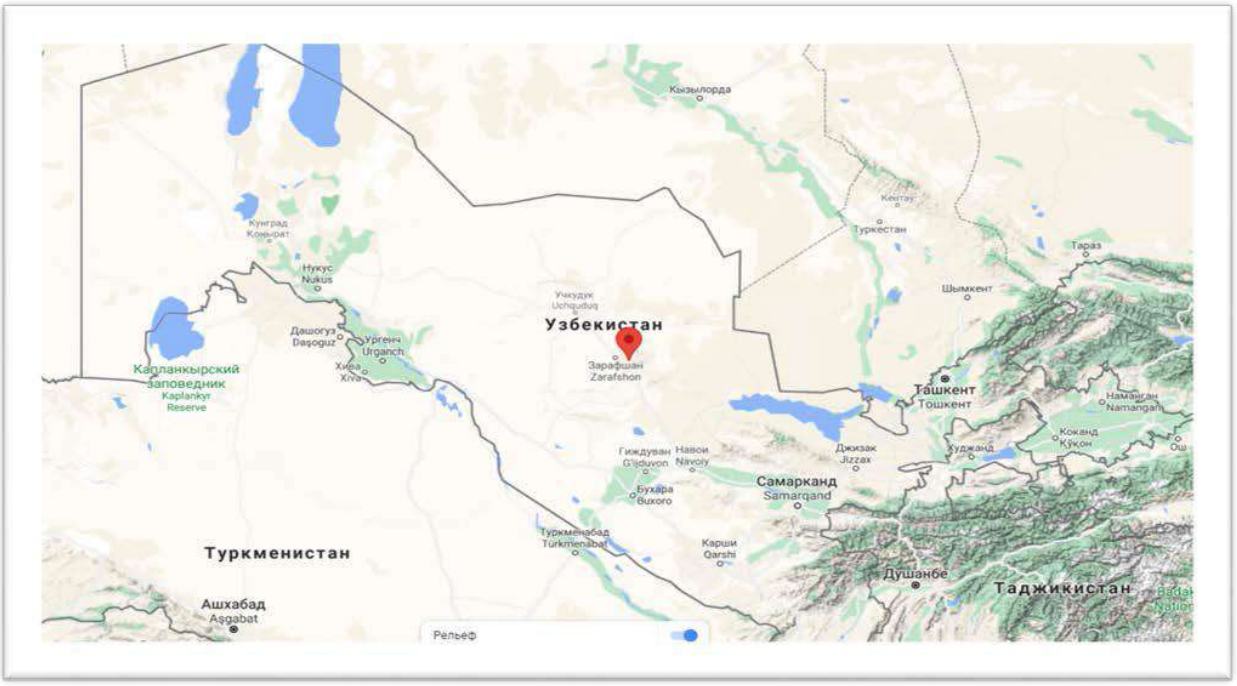


Fig. 1. Location of the Tamdytau Mountains

The Tamdytau Mountains are located in the immediate vicinity of Zarafshan (3 km to the east). The total length is about 56 km (Fig. 1). Consists of latitudinal rocky ridges, individual rocky hills. The massif is composed of sandstones, shales, limestones with intrusions of granites and granodiorites.

3. RESULTS

Potential shelters in the study region can be divided into the following categories:
mine gallery (horizontal or inclined mining with direct access to the earth's surface), mine shaft (vertical or inclined mining with direct access to the surface), wells, grottos, caves, crevices in the rocks, sheep cotes, abandoned Soviet buildings (farms, small settlements).

A total of 25 potential shelters were visited, including mine shafts (3), mine galleries (2), wells (11), caves (1), sheep cotes (3), abandoned settlements (1), burial grounds (1), niches (2) (Fig.2). In Table 1, all potential bat shelters visited during the field trip are presented in detail.

Table 1. Results of surveys of potential bat shelters in the Tamdytau

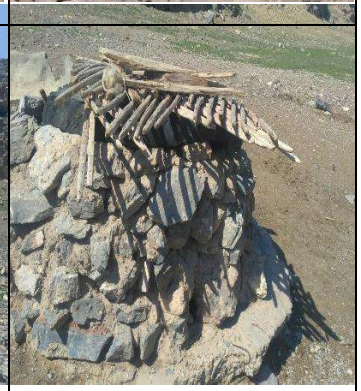
№	Geographical name	N	E	Type of	Description	Presence/absence of bat	Figure
1	Tamdytau, north-east of Zarafshan	41.561693	64.254532	Mine gallery or shaft (?)	Nearby is a mining operation. Access is prohibited. A special admission for the survey is required.	Unknown	Protected object. Photographing is prohibited.
2	Tamdytau, north-east of Zarafshan	41.574151	64.270410	Mine gallery or shaft (?)	There is a military training ground (shooting range). A special admission for the survey is required.	Unknown	
3	Tamdytau, north-east of Zarafshan	41.574151	64.270410	Mine gallery or shaft (?)	There is a military training ground (shooting range). A special admission for the survey is required.	Unknown	Protected object. Photographing is prohibited.

4	Kushtutby Well	41,604579	64,263716	Well	A well with water, in use. Concreted and covered with a lid, but cracks remain. The inside is lined with stones. The shepherd never saw any bat flying out.	Not detected	
5, 6	Western tip of Tamdytau	41,59588	64,30907	Grotto (2 nearby)	Shallow grottoes (height 1-1.5 m, depth 1.50-2 m), with numerous slits clearly visible. Excrement of the chuckars and foxes		
7	Western tip of Tamdytau	41,59657	64,30908	Grotto	A shallow grotto, with well-visible crevices	-	

8	Western tip of Tamdytau	41.583432	64.321354	Mine gallery	The mine gallery is dry, with humid air. The total length is about 60 m. Visited by people, the torches were burnt inside, there	Old excrement has been observed. It can be used as breeding grounds and wintering grounds. It is necessary to check in the summer. According to the survey data of the shepherd, bats	
9	Karatash and Kudukcha	41.611150	64.348130	Wells (2)	Indicated on the topographic map, but there were none in real	-	-
10	North-eastern Tamdytau Dzhaksan 1	41,59134	64,43537	Well	Covered with a loose lid. Concrete. In use. Used by chuckars for drinking water.	-	

11	North-eastern Tamdytau Dzhaksan 2	41,59480	64,43589	Well	A deep well, of stones, encased in concrete. In use. Many cracks in the masonry both inside the base and outside	Probably used as a temporary shelter by bats. In the depths, on the rocks, small excrement, similar to bats.		
12	North-eastern Tamdytau	41,590744	64,439987	Grotto	Against the background of the rock massif, gave the impression of a deep cave. During the survey it was found out	-		

13	Yamankurgan-1	41,62436	64,52550	Well	In use. The top is covered with a lid.	-	
14	Yamankurgan-2	41.626249	64.526981	Well	The well is dry, concrete. There are cracks, but not many.	It can potentially be used as a temporary shelter.	
15	The Dzamankan gyr well.	41.634728	64.540601	Burial ground	Indicated on the topographic map, but there is none in real	-	-
16	The Dzamankan gyr well.	41,63370	064,54119	Niche	Shallow niche along the sai (small river), with cracks. The inside of cracks is clearly visible with a flashlight. The total length is about 30	-	

17	Untitled	41,61323	64,35925	Well	Indicated on the topographic map, but there is none in	-	-
18	Karatash	41,61125	064,37884	Well	Indicated on the topographic map, but there is none in	-	-
19	Western part of Tamdytau	41,585701	64,502747	Sheep cote	Abandoned sheep cote. Concrete building, no roof. There are practically no crevices. There are no suitable shelters for bat.	-	
20	Western part of Tamdytau	41.569840	64.521860	Cave	A potentially deep cave. We climbed to the top of the rock mass, but the descent without strapping and rope seems impossible.	Unknown	
21	Western part of Tamdytau	41,56463	64,51645	Sheep cote and wells	Two wells, one is abandoned and buried, the second is closed, but there are cracks. Nearby is an abandoned sheep cote made of stones, with many crevices	Potentially can be used as a temporary shelter.	

22	Bozdon area	41,561483	64,480087	Sheep cote	The ruins of an old sheep cote made of stones. There are cracks, but they are clearly visible	-	
23	South-west Tamdytau	41.536338	64.388816	Shaft, village	Mine shaft (vertical), the descent is impossible and near the ruins of the village with a lot of shelters	Unknown, but most likely used by bats as shelters.	
24	South-west Tamdytau	41.557647	64.382591	Mine gallery	It is located on the territory of the recreation centre "Cold Keys". During the survey, we were not allowed to enter the territory. According to the interviewed local people from Zarafshan, the mine gallery is	Unknown, but most likely used by bats as shelters.	No admission

25	South-west Tamdytau*	41,554008	64,327858	Rocks	Like most rock formations, there are potential crevices that are difficult to access for surveys.	Common pipistrelle (*Pipistrellus pipistrellus*) detected by mobile Ultrasound detector	

* places where ultrasonic signals of bats are recorded

Thus, 5 objects were actually suitable for bats. Without access, for various reasons (see Table 1) there were 6 objects - 4 mine galleries, 1 mine shaft and 1 cave, which are potentially inhabited by Chiroptera in this region.

Table 2. Assessment of suitability of surveyed objects for bats***

Shelter No.	Degree of suitability *	Degree of disturbance	Notes
4	**2**	4	The well is used for drinking water
5,6	1	4	Easy access for predators and
7	1	4	Easy access for predators and
8	4	4	Regularly visited by people
10	**2**	4	The well is used for drinking water
11	3	4	The well is used for drinking water
12	1	2	Access for predators
13	1	4	Easy access for predators and
14	3	**2**	
16	1	4	Easy access for predators and
19	1	1	
21	3	2	
22	**2**	2	
25	**3**	2	

Note: *1 – not suitable; 2-places potentially used as short-term shelters; 3-potentially suitable as a temporary summer shelter; 4-suitable as a permanent shelter (wintering, breeding).
* * 1-absent; 2-weak; 3-medium; 4-high.
*** numbering in table 2 corresponds to the number of shelters in Table 1. Wells/ruins not found in field and places without access are omitted.

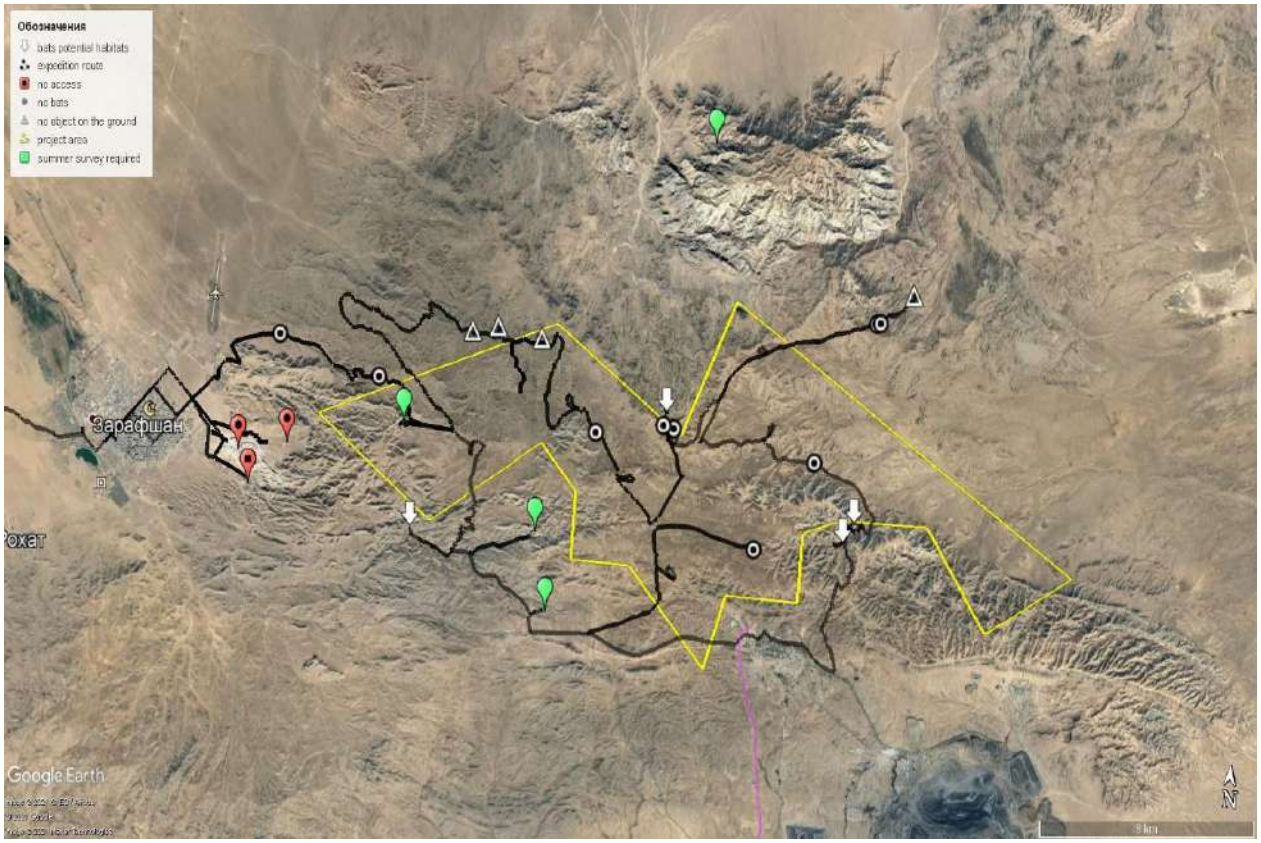


Fig. 2 Surveyed areas

Potential shelters were divided according to the degree of suitability for bats (Table 2).

Completely unsuitable are 6, 3 – potentially used as short-term shelters; 4 - can be used as a temporary summer shelter and can be regarded as a shelter suitable for permanent habitat (breeding, wintering).

Fig. 2 shows schematically the surveyed sites by degree of suitability and accessibility.

CONCLUSIONS

Thus, as a result of the field survey, a significant area with 25 potential habitats was studied.

However, bats were not found directly in the shelters, but traces of their presence were found – excrement (in two places).

The result was largely influenced by the lack of access to a number of mine galleries and not visiting the cave in the Aktau (Tamdytau) remnant, located five kilometres from the project area, in which in 2014 the authors of the report found a fairly large colony of the Bokhara horseshoe bat (Rhinolophus bocharicus), more than 50 individuals and several individuals of the Lesser mouse-eared bat (Myotis blythii). For most species of Bats, a distance of 5-10 km is a feeding ground, so it is important to conduct the survey of this cave in the summer period of this year.

Fig. 3. shows the places necessary for visiting in the summer period of the year, where in case of bats detection, species, their number and reproductive state (breeding/non-breeding individuals), presence of brood colonies will be determined.

Ultrasonic signals will be recorded using mobile detector. Near each of the shelters, in addition to visual inspection, observations of bats flying out to forage are planned, which will make it possible to determine a more accurate number of bats - **bat emergence survey**.

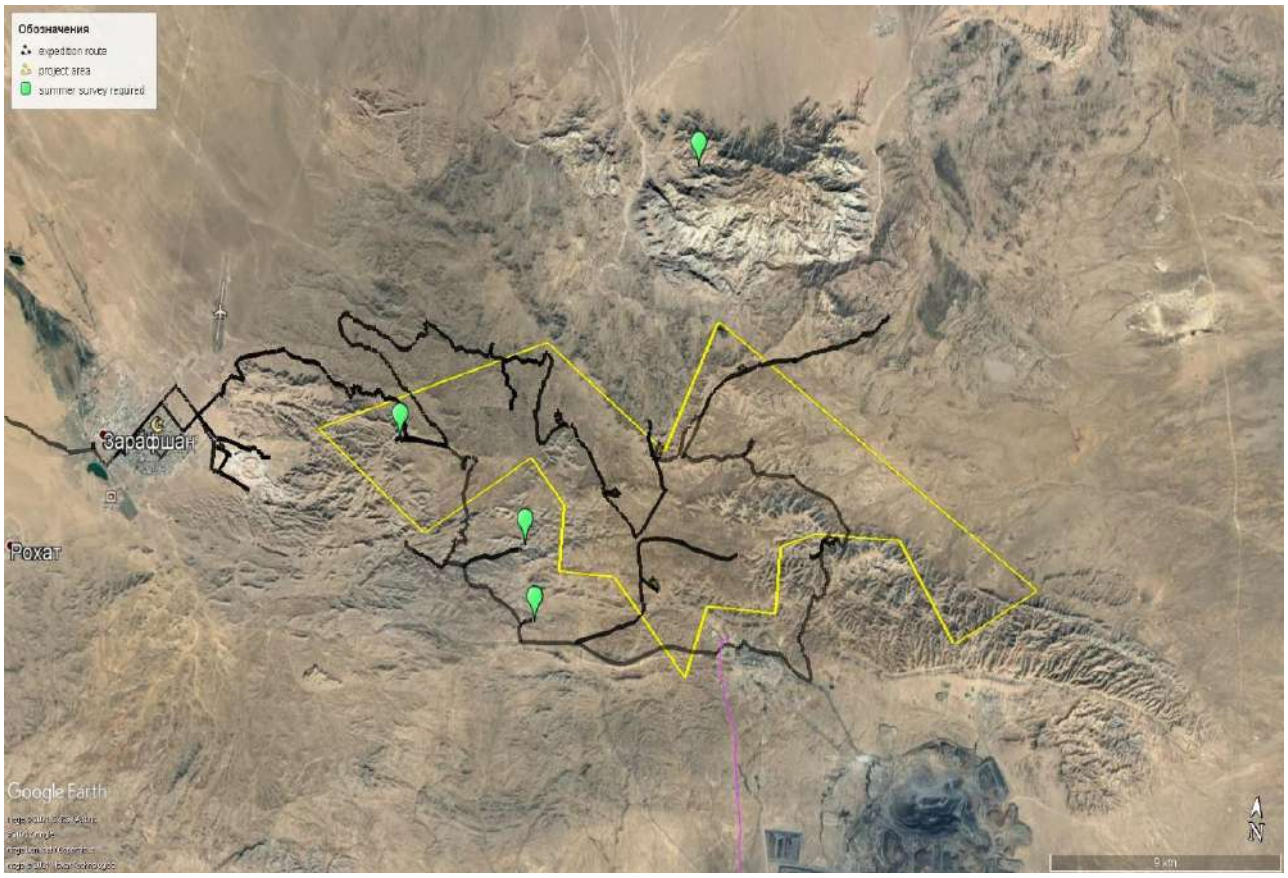


Figure 3. Shelters recommended for surveys in the summer period of the year (June).

RECOMMENDATIONS

1. To check the identified potential shelters in June (the breeding season).
2. To check the presence/absence of drain tunnels on the Zarafshan – Muruntau highway.
3. To conduct a bat emergence survey: quantitative survey of bats flying out to feed from the shelter, and record ultrasound (mine tunnels/shafts and a cave in Aktau). At least three nights.
4. In the future, in the case of monitoring on the territory, it is necessary to organize the collection of genetic material and obtain all permits for this from the State Committee for Natural Resources.

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Appendix 1. Additional photographic material

Figure 1. Survey of the well for the presence/absence of bats.

Figure 2. Mine gallery in Tamdytau

Figure 3. Remains of geological workings. Unburied test pit.

Figure 4. Destroyed building with cracks. A potential temporary shelter for bats.

Figure 5. Cracks between the stones - potential temporary shelters.

Figure 6. Cracks between the stones - potential temporary shelters.

Figure 7. Cracks between the stones - potential temporary shelters.

Figure 8. Power line along the ridge.

Figure 9. Power lines, road network and Tamdytau valley.

Figure 10. Power lines and rock ridge.

Figure 11. Flattened rocky slopes without cracks for shelters.

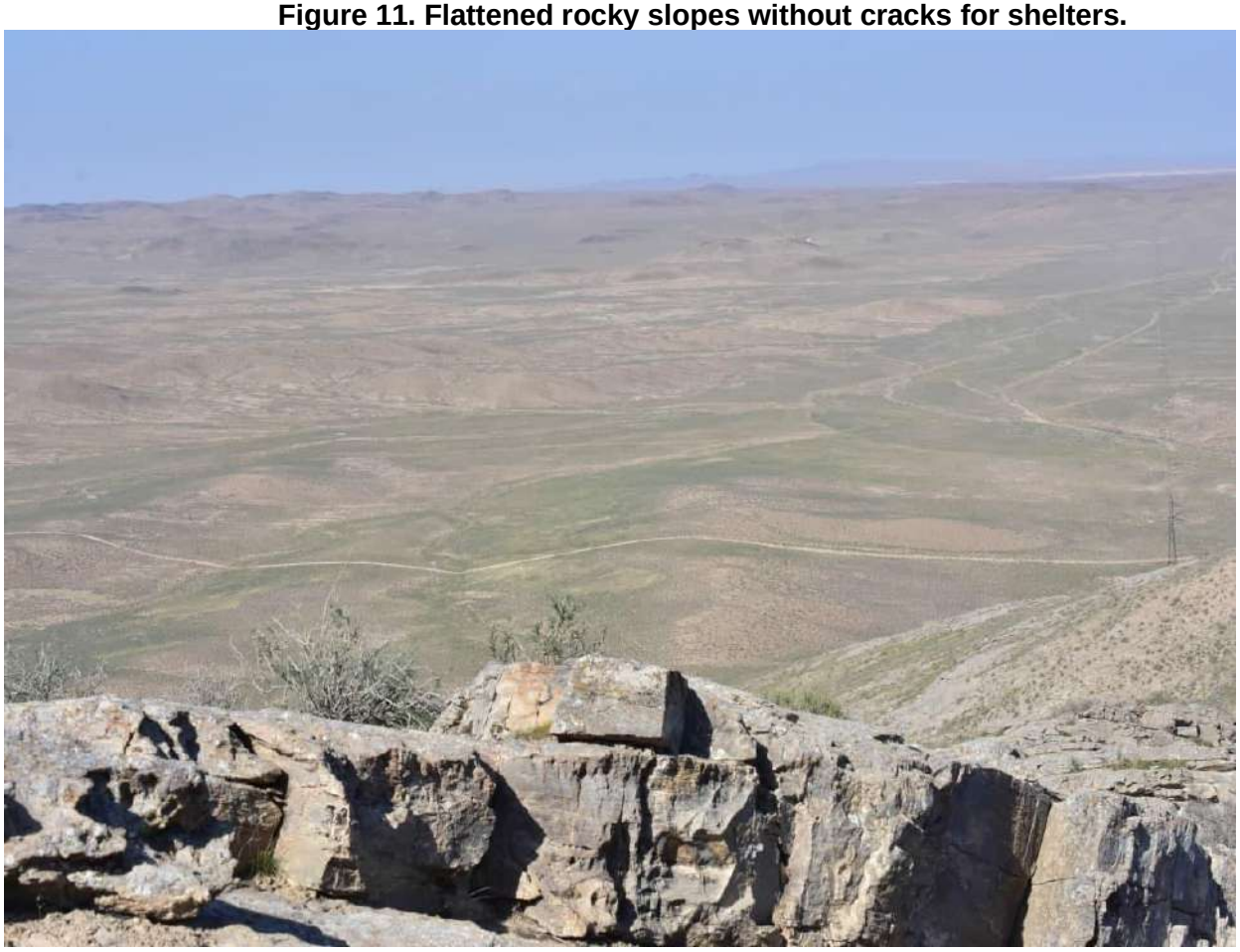

Figure 12. Tamdytau Valley.

Figure 13. Flattened rocks

Figure 14. Flattened slopes

Figure 15. Wind mast on the slopes of Tamdytau.

Figure 16. Expedition vehicles on the slopes of the Tamdytau Ridge.

Juru Energy

BAT ROOST SEARCH
OF THE RESIDUAL MOUNTAINS OF TAMDYTAU
(NAVOI REGION, KYZYLKUM DESERT)

ZARAFSHAN WIND FARM PROJECT:
CLIENT: WOOD GROUP
Date: July 2021

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Contents

INTRODUCTION 2
MATERIALS AND METHODS 2
Equipment 3
GEOGRAPHICAL FEATURES OF THE STUDIED AREA 4
RESULTS 6
Bokhara horseshoe bat (*Rhinolophus bocharicus*) 7
Ognev's serotine bat (*Eptesicus bottae ognevi*) 11
Common pipistrelle bat 14
CONCLUSIONS 16
RECOMENDATIONS 17
REFERENCES 18
Appendix 1. The results of the potential bat roosts survey on the Tamdytau ridge and in the adjacent territories 19
Appendix 2. Additional photographic material 31

INTRODUCTION

Bats (*Chiroptera*) are the second largest order of mammals in Uzbekistan. At the moment, there are 21 species of Bats known in Uzbekistan, however, this order is the least studied, especially in remote desert areas.

This report contains the results of the survey in the Tamdytau in the period from 26 to 29 June 2021.

This report contains the results of the survey in the Tamdytau in the period from 15 to 17 April 2021. The aim of the survey was to determinate the presence/absence of Bats in potential roosts identified as a result of the processing of topographic and literary material. In case of a bat detected, it was planned to determine it the species, record their number and reproductive status (breeding / non-breeding individuals), the presence of brood colonies. In addition to measuring and photographing the detected species, it was planned to use mobile bat detectors to make "reference" recordings of ultrasonic (ultrasonic) signals for species identified. These "reference" signals will be used in the future for further decoding of audio recordings of static bat detectors from project sites and transects, since some species of bats of Uzbekistan are absent in Europe and the parameters of ultrasonic signals are not known for them.

MATERIALS AND METHODS

The methods were divided into two stages:

Desktop preparation for the survey, included the analysis of detailed topographic maps of the area (scale: 1:100 000, 1:200 000) and Google Earth satellite images. The maps identified the locations (GPS coordinates) of potential bat roosts – caves, mines, human buildings, wells, burial grounds and were transferred to the LocusPro program for further use in the field. A total of 16 locations were identified for the survey at this stage.

Field work included a survey of potential roosts selected during the desktop analysis. Rock outcrops with crevices and caves were identified on the spot. When a roost was found, it was carefully examined, both for the presence of bats themselves, and for indirect signs of their presence – excrement, food remains (insect wings, legs, etc.).

In addition to pre-identified roosts, during the field survey the most used bats roosts were found – the draining tunnels under the roads. These are concrete or iron structures (the latter are not used by Bats) of various sizes and shapes, laid under highways or railway tracks, in order to divert mudflows from the residual mountains during seasonal

precipitation.

Each surveyed object was mapped, photographed, its brief description was made, including notes on the suitability of the objects for bats as either a temporary roost or a permanent one, notes on the potential degree of disturbance/threat. Where necessary the height, width and length of the roost were measured. In case of detection of Bats, the surface temperature was measured. All the draining tunnels examined in spring were re-examined in summer. We also examined areas that go beyond the project territory, because bats fly long distances (up to several kilometres) from their roosts in search of food.

When Bats were detected, their species, gender, age and number were determined. Species identification was carried out according to generally accepted methods (Kuzyakin, 1950; Bogdanov, 1953; Dietz, von Helversen 2004). The captured bats were examined, photographed and immediately released in the places of capture. For two discovered species – the Bokhara horseshoe bat (*Rhinolophus bocharicus*) and the Ognev's serotine bat (*Eptesicus bottae ognevi*), measurements were taken confirming the species identity and recordings of echolocation signals were made.

In total, 315 km (Spring and Summer expeditions) were covered by survey transects, 23 potential roost places were examined.

Equipment

To navigate the terrain and record tracks, a smartphone *(BV9900E)* was used with the *LocusPro* application installed, with preloaded *Google Hybrid* and *Marshruty.ru* maps. Two binoculars were used to view the area: Nikon Aculon 10x42 and *Nikon Prostaff 7S 10x42*.

Photographing was carried out using smartphones *(BV9900E)* and *MIUI REDME 5+*, as well as two SLR cameras: *Nikon D3200* with a *Nikkor 18:200* lens and *Nikkon D3200* with a *Nikkor 50 mm* lens.

The following equipment was used for the examination of bat roosts: a torch (*Fenix HP30R)* (2), cloth bags (2), thick gloves (2), forceps (2), a tape measure (1), a surface electronic thermometer *TFA* (1), an electronic scale *SF-400* (1), a *Digital caliper 0-150 mm* caliper (1), a mist net (1), and the radiation level in the mine galleries/ mine shafts was measured by a *Geiger counter ZGKPDQ*. Recordings of ultrasonic signals were carried out using *Echo Metr Touch 2 Pro for Android wildlife Acoustics*.

All the collected information was recorded in a notebook, the surveyed roosts and bats registration locations were mapped in the *LocusPro* smartphone application.

GEOGRAPHICAL FEATURES OF THE STUDIED AREA

Tamdytau is located in the Kyzylkum physical-geographical region. It is placed in the center of the plain part of Central Asia, which is associated with desert landscape. This physiographic area includes the western part that belongs to Uzbekistan and the Kyzylkum desert, while its northern and eastern parts are in Kazakhstan. It borders with Kazakhstan to the north, with Turkmenistan to the southwest, with Mirzachul region to the east, with Zarafshan to the southeast and with the Zarafshan region in the west. The surface of the area in the direction from southeast to north-west slightly decreases. The average height is 200-300 m, in the southeast the height reaches 350-400 m, in the north-west-only 100 m.

The lowest point is the Mingbulak Depression, 12 m below sea level. The highest point is Aktau peak (height 922 m) of Tamdytau mountain. The relief of the Kyzylkum region is diverse.

There are plains, remnant mountains and depressions located between the mountains. However, most of Kyzylkum consists of plains with an absolute height of up to 200 m. The main part of the plain is occupied by sand ridges, sand hills, dunes, takyrs. Dunes are found mainly on the banks of the Amu Darya and around wells. Sand ridges and hills are fixed by plants. The inter-ridge depressions are occupied by takyrs. Autumn in Kyzylkum is mostly dry. The annual precipitation is small (up to 75-100 mm), and it is distributed unevenly over the seasons. The main part of the annual precipitation falls in the spring (up to 48%) and winter (up to 30%), but evaporation reaches up to 1000-1500 mm.

There are no permanent watercourses in Kyzylkum. Only the Amu Darya River passes through the southwestern part of the area. However, in the spring, as a result of rains and snow melt, temporary flows form on the slopes of low mountains, which quickly dry up. In the strata of Mesozoic and Paleogene sediments, there are fresh artesian waters. Mineral thermal waters have also been found in Paleozoic sediments.

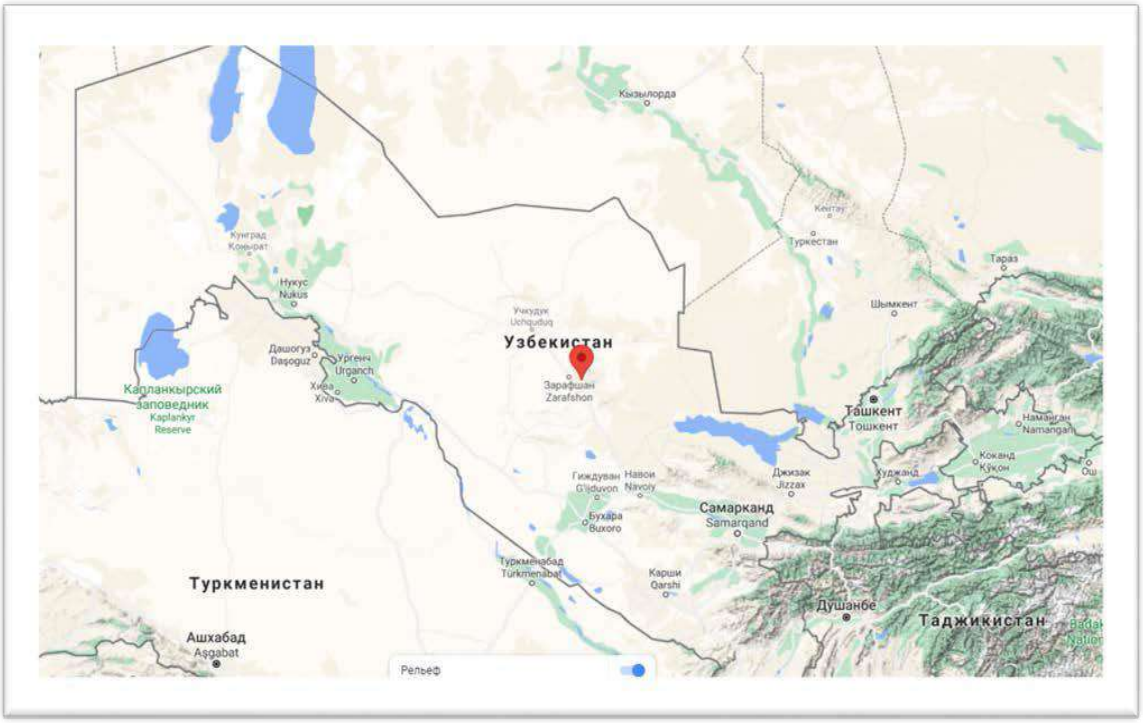


Figure 1.Location of the Tamdytau Mountains

The Tamdytau Mountains are located in the immediate vicinity of Zarafshan (3 km to the east). The total length is about 56 km (Fig. 1). Consists of latitudinal rocky ridges, individual rocky hills. The massif is composed of sandstones, shales, limestones with intrusions of granites and granodiorites.

RESULTS

Potential bat roosts in the studied region can be divided into the following categories: **anthropogenic** – the draining tunnels under the roads, mine galleries (horizontal or inclined mining that has direct access to the surface) **natural** – grottos, crevices, caves.

A total of 23 potential habitats were visited (Fig.2): draining tunnels under the roads and railway (19), grotto (1), cave (1), mine galleries (2)

In Appendix 1, all the potential roosts visited during the field trip are described in detail.

Figure 2. Surveyed locations

Almost all surveyed habitats are suitable both for breeding and as a temporary roost.

Roosts suitable for breeding offspring – are draining tunnels with deep crevices where bats were found or can potentially be inhabited by them in the future, as well as the mine gallery (2) and mine shaft (2), (fig.2 №№ 22-23) which may have previously been the habitat of bats but were buried.

Only the mine gallery (see Fig. 2, no. 19) seems to be suitable for wintering.

It is not known how much the bats use the drain tunnels in winter, most likely due to low temperatures the concrete cools considerably, which is not an acceptable condition for

wintering. Thus, there are actually 21 roosts suitable for bats to live in.

Below is more detailed information on the three visually recorded species of bats on the project area:

Bokhara horseshoe bat (*Rhinolophus bocharicus*)

Bokhara horseshoe bat (LC, IUCN) is a Central Asian endemic inhabiting Afghanistan, Iran, Kazakhstan, Kyrgyzstan, Tajikistan (Benda et al, 2019) (Fig. 3). Bokhara horseshoe bat is listed in the Red Book of Tajikistan (2015).

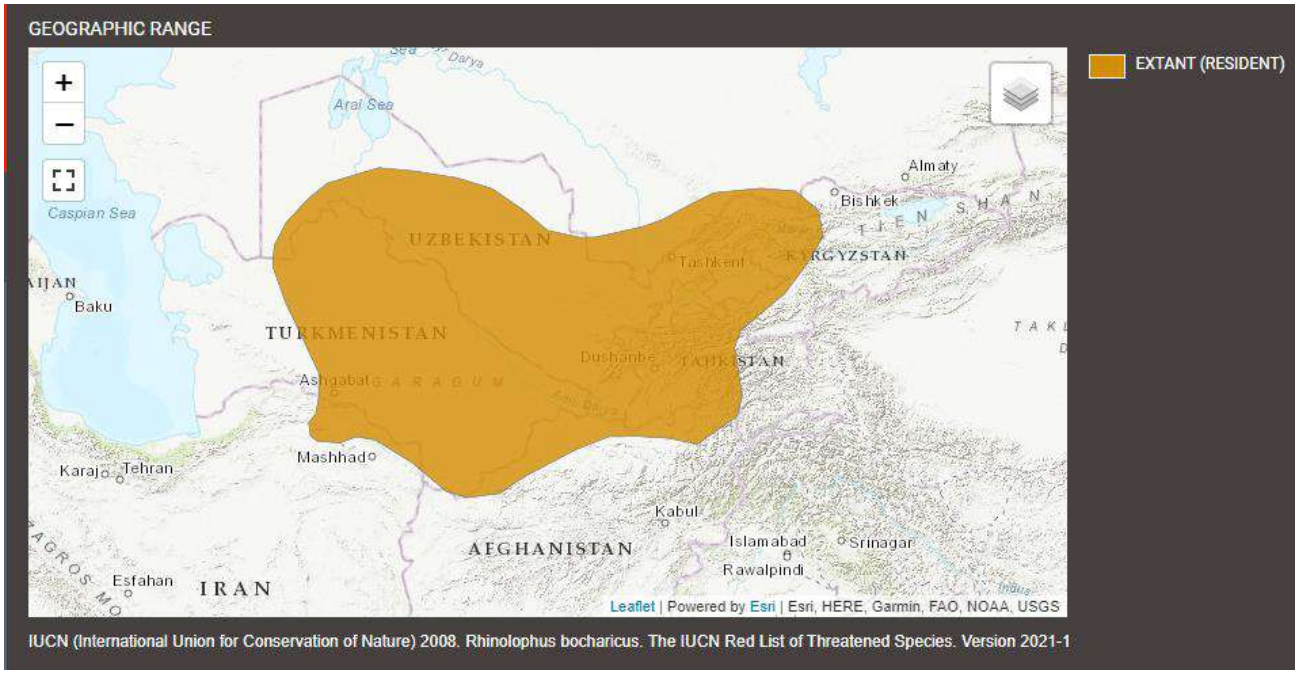


Figure 3.The world habitat areas of the Bokhara horseshoe bat

It was confirmed (see report No. 1) that a colony of Bukhara horseshoe bats lived in a natural cave in the Aktau mountains (Fig. 4). The Cave is located in a gorge, among granite rocks (Fig. 5. and 6). The height is up to 2m 80 cm, width - 1.5 m. The total length is about 3 m. The temperature of the walls is 30.7°C. A total of 58 adult females sitting on the ceiling at a height of 2 m were taken into account. 54 females lactating with half the size of adult cubs (Fig. 7 and 8). The number of cubs in each female is 1. Thus, the total number of horseshoe bats is about 112 individuals. There are no other Bat species in the cave.

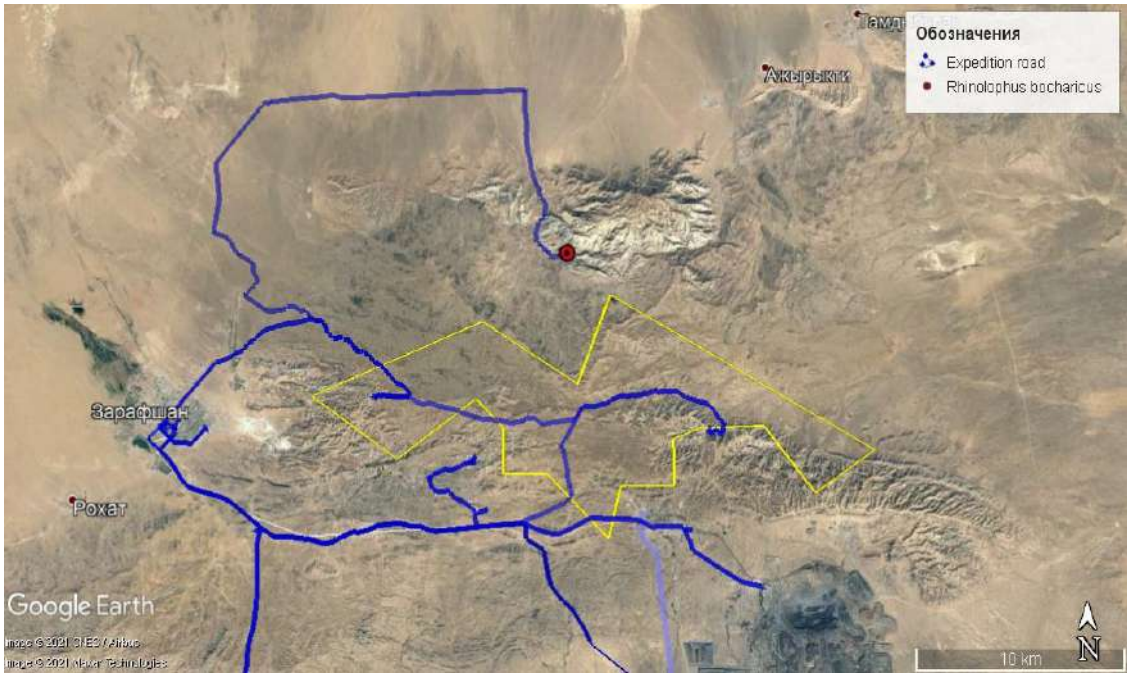
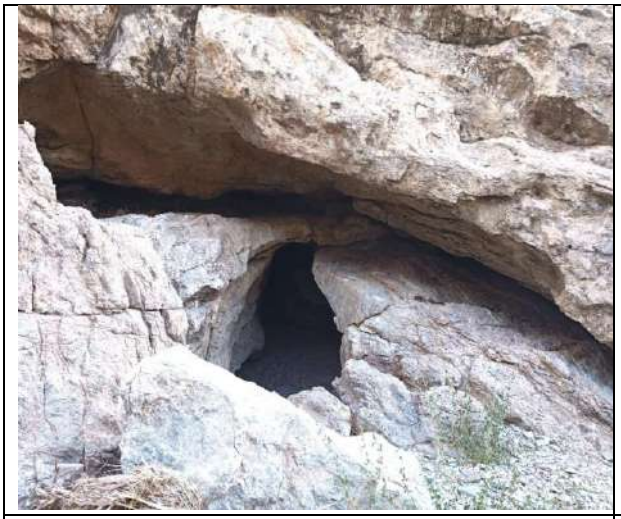


Figure 4.The location of the mine gallery with a colony of Bokhara horseshoe bats



A cave with a colony of Bokhara horseshoe.

Granite massifs of the gorge.

Figure 5. Habitats of horseshoe

Figure 6. A group of female Bokhara horseshoe bats in a cave.

We captured a female and recorded ultrasound signals (The ultrasound recordings were provided to the international bat expert Dr. Vasenkov D. N.) and the bat was released back to the cave. Lifetime measurements were taken in a female and a young individual (Table 1).

Table 1 Measurements of a female and a young male of Bokhara horseshoe bat

Measurements (mm)	♀	**Juv ♂**
Body length	39	29
Tail length	25	22
Forearm length	50	44
Ear Length	21	12
Wing length	143	112
Horseshoe Width	8	7
Weight (g)	12	8

Figure 7. Bokhara horseshoe bat with a pup

People do not visit the gallery. By the amount of excrement, it can be concluded that the colony has been here for many years. This makes the area important for the conservation of the Bukhara Horseshoe bat population, especially in desert conditions, where similar roosts suitable for colonies are highly limited.

Ognev's serotine bat (*Eptesicus bottae ognevi*)

Ognev's serotine bat (LC, IUCN) is a widespread, but naturally small in numbers species in the studied region. Ognev's serotine bat is listed in the Red Book of Tajikistan (2015). Ognev's serotine bat was observed only in the draining tunnels under the roads in the surveyed territory, however, according to the literature data (Bogdanov, 1953), it is possible that there are also natural roosts – cracks and crevices in the rocks, which were not examined by us due to difficult accessibility and time constraints.

We examined a total of 18 draining tunnels (Fig. 7), bats were found in 15 tunnels, excrement in 3 tunnels, and two Ognev's serotine bats were recorded in main gallery **(more detailed information on each tunnel is given in Appendix 1).**

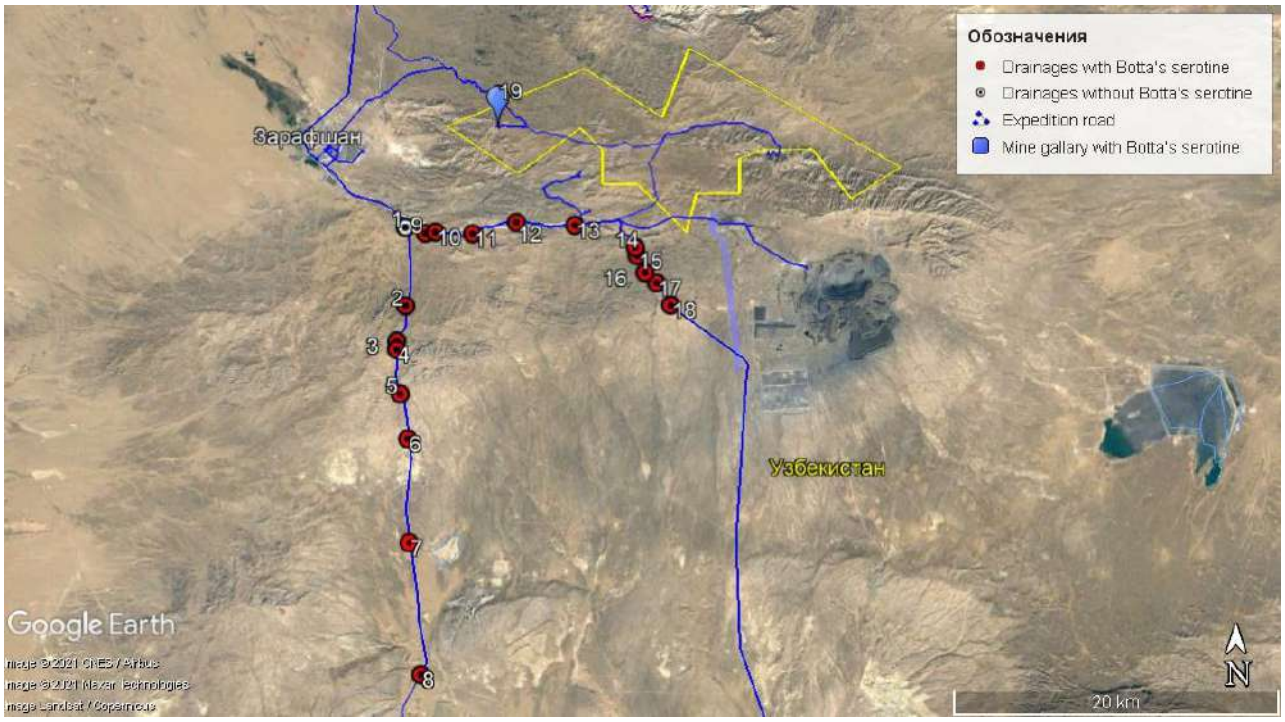


Figure 8.Places of registration of the presence of Ognev's serotine bat.

In total, 155 Ognev's serotine bats were recorded, including 85 females, 62 males and 8 individuals, which could not be examined to identify gender. Each draining tunnels was numbered by us (Fig. 7, Appendix 1). Table 1 shows the data on the gender and age composition of bats in each draining tunnel.

In Uzbekistan, according to literature data, the majority of male bats stay alone and disperse over a wide area in summer, while females form large colonies, which become obvious due to continuous squeaking (Bogdanov, 1953).

The data we collected (Table 1), indicate different types of colonies - colonies of females with cubs; males in small groups, pairs or singly; mixed groups of males and females; and colonies with breeding females with cubs and males. Thus, during the breeding period, Ognyov's serotine can form mixed colonies of individuals of different sexes and ages. It should be noted that females have one or two cubs.

Table 2 Gender and age composition of Ognev's serotine bats in each surveyed draining tunnel and main gallery

Draining tunnel №	♂	♀	Juv	Gender is not known	The surface temperature t°C	Comments
2	2	-	-	-	28,8°	
3	-	-	-	1	29°	The Bat flew out
4	1	-	-	-	31,5°	
5	-	1	-	1	31,9°	Could not extract it
7	2	37	16	1	34°	
8	14	1	-	-	32°	
9	-	11	19	-	34°	
10_ **Draining tunnel under railway**	-	10	10	-	34°	
10_ **Draining tunnel under road**	2	2	-	-	35,5°	
11_ **Draining tunnel under railway**	-	-	-	1	34°	Could not extract it
11_ **Draining tunnel under road**	1	-	-	-	30,9°	
14	8	-	-	-	32,1°	
15	6	-	-	-	32,9°	
16	6	2	-	4	33,6°	Could not extract it
17	15	8	5	-	33,9°	
18	3	13	8	-	34,3°	
19	2	-	-	-	24-26,6°	Main gallery

In colonies with Ognev's serotine bats, a small number of **Common pipistrelle bat**s were recorded (see below), this observation is interesting due to the fact that it does not coincide with the observation of A. P. Kuzyakin (1950). He observed a situation when, Common pipistrelle bat climbed into the hole in the fence where Ognev's serotine bat sat at dawn, and Ognev's serotine bat made Common pipistrelle bat leave the roost. The author concluded that Ognev's serotine bat probably does not get along with other species. Our data indicate the use of drains, and even the same crevices by individuals of these two species.

The surface temperature inside the draining tunnels, even on the hottest days (up to 45° C),

remains within the range of 28-35.5°C.

An obvious anthropogenic threat to Ognev's serotine bats is the regular repair work of draining tunnels, as a result of which the cracks inhabited by this species are smoothed. No other obvious anthropogenic threats were noted, which is due to the remoteness of colonies of this species from human habitation.

In general, the Ognev's serotine bat is a regularly occurring but naturally small in numbers species on the studied territory.

Common pipistrelle bat

Common pipistrelle bat (*Pipistrellus pipistrellus*) is one of the most common and widespread species of Uzbekistan (LC, IUCN), whose roosts are mainly confined to human buildings.

In Uzbekistan, according to literature data, the majority of male bats stay alone and disperse over a wide area in summer, while females form large colonies, which become obvious due to continuous squeaking (Bogdanov, 1953).

Large colonies of bats were not found in the project area; obviously, the largest colonies are located in populated areas such as Zaravshan, Muruntau, etc. However, small numbers of bats were found together with Ognev's serotine bat (Fig. 8).

In total, 14 Common pipistrelle bats were recorded, including 1 female, 9 males and 4 individuals, which could not be examined to identify gender. Each draining tunnels was numbered by us (Fig. 8, Appendix 1).

Table 2 shows the data on the gender and age composition of bats in each draining tunnel. From the collected data, it becomes obvious that breeding females keep separate colonies, males keep alone. The surface temperature inside the draining tunnels, even on the hottest days (up to 45° C), remains within the range of 28-35,5°C.

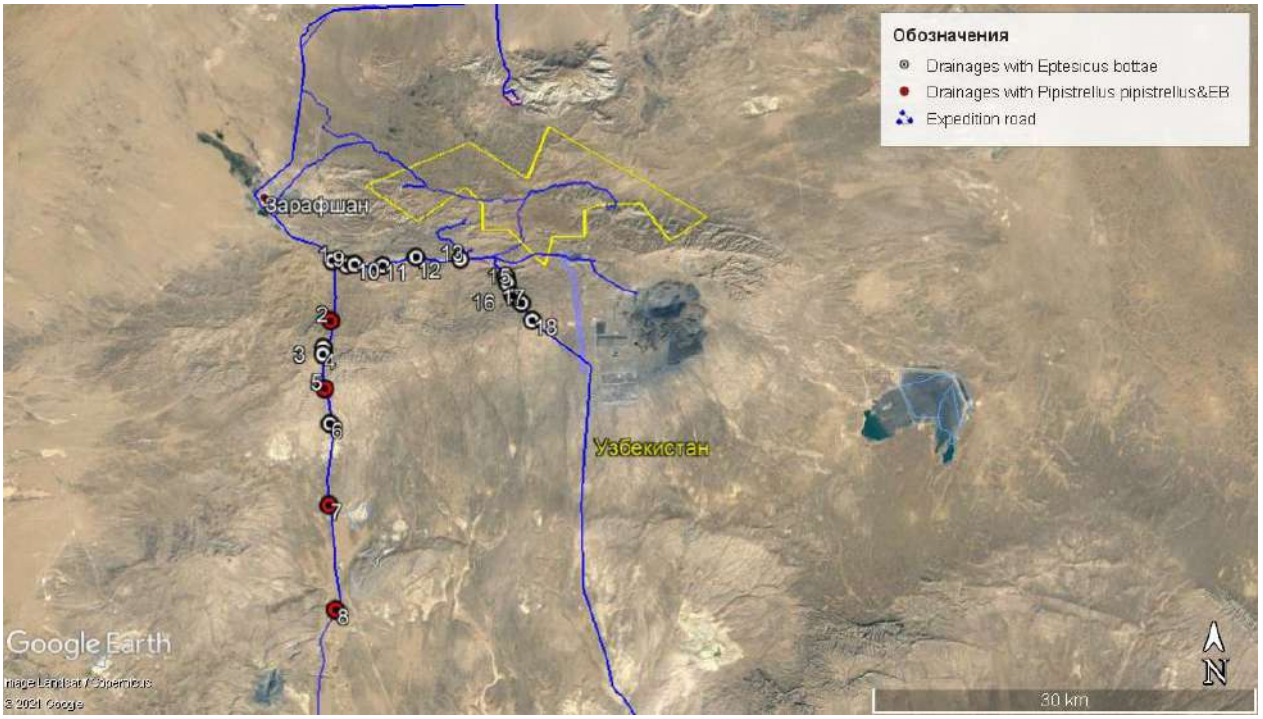


Figure 9 Places of registration of the Common pipistrelle bats

Table 3 Gender and age composition of Common pipistrelle bats in each surveyed draining tunnels

Draining tunnel №	♂	♀	Gender is not known	The surface temperature t°C	Comments
2	1	-	-	28,8°C	
5	-	-	1	31,9°	could not be extracted
7	6	1	3	34°	could not be extracted
8	2	-	-	32°	

Figure 10.Common pipistrelle bat

CONCLUSIONS

Our survey of the project territory was carried out first during the migration period, and then during the most important period in bats' life – pregnancy and breeding.

This allowed us to obtain information on the biology of three species present in the project area:

- Ognev's serotine bat
- Bokhara horseshoe bat
- Common pipistrelle bat

With the help of mobile detectors, the ultrasonic signals of two species (Ognev's serotine bat, Bokhara horseshoe) were recorded bat signals analysis.

As a result of the field visit, a significant area with 23 potential roosts was surveyed.

– 19 draining tunnels under the roads and railway, 1 grotto, 1 cave и 2 mine gallery.

Almost all surveyed habitats are used by bat for breeding and as temporary roots. Only the mining galleries is suitable for wintering. Two mines were buried. In total, 21 roots were used as active habitats were found.

We obtained new information on the ecology of the Ognev's serotine bat not previously indicated in the available literature sources.

The level of existing anthropogenic threats in the studied territory is associated with human activity. The most significant threats are: the planned repair work in the draining tunnels under the roads, when the cracks that are used by the Ognev's serotine bats are being smoothed; and the destruction of bat colonies in residential settlements both purposefully and accidentally.

In general, the bats population density on the project territory is quite low, which is due to the harsh desert conditions and limited places of permanent roosts, which are mostly human buildings. Thus, the development of the desert territory and the development of infrastructure significantly affected the bats population. This issue needs to be studied in more detail.

RECOMENDATIONS

1. Conduct a winter survey for the presence/absence of bats;
2. Install an iron grid (with a lock) with large gaps at the entrance of the mining gallery in the project area to completely fence off the mining gallery from visitors and help to preserve the habitat of bats. These measures should be approved by NGMC (Navoi mining and metallurgical combinate).
3. Conduct a meeting with NGMC management to explain the importance of preserving mine galleries and shafts as key roots for the bats. Offer to install iron grids at the entrances.
4. Conduct operational bat monitoring after the completion of the construction of the wind farm, especially during the period of seasonal migrations and breeding;
5. During operational monitoring, it is necessary to organize the collection of bat genetic material. For this purpose, it is necessary to obtain all permits from the State Committee of Ecology and the Academy of Sciences of the Republic of Uzbekistan.

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Appendix 1. The results of the potential bat roosts survey on the Tamdytau ridge and in the adjacent territories

№	N	E	Type of roost	Description	Presence/absence of bat's	Photo	
1	41,52804	64,25368	Concrete draining tunnel under the railway,	Length 7 m, height 1 m. There is one suitable crevices. Can be used as a temporary roost, Not suitable for breeding and colony.	Not detected		
2	41,48446	64,25460	Concrete draining tunnel under the road	Length 27 m, height 125 cm. Many suitable deep crevices, including for breeding. t=28.8°C	*Eptesicus bottae* (2 ♂) and *Pipistrellus pipistrellus (1* ♂)		

3	41,46509	64,24824	Concrete draining tunnel under the road	Length 27 m, height 1 m. A few crevices. Can be used as a temporary roost, not suitable for breeding and colonization. t=29°C	*Eptesicus bottae* (1). It was not possible to extract it for examination	
4	41,46043	64,24803	Concrete draining tunnel under the road	Length 27 m, height 1 m. A few crevices. Can be used as a temporary roost, not suitable for breeding and colony. t=29°C	*Eptesicus bottae* (1♂).	

5	41,43586	64,25076	Concrete draining tunnel under the road	Length 20 m, height 1.5 m. Many deep crevices, suitable for breeding. t=31.9°C	*Eptesicus bottae* (1♀ + 1 flew away) *Pipistrellus pipistrellus* – was not possible to extract it for examination	
6	41,41114	64,25643	Concrete draining tunnel under the road	Length 16 m, height 1.5 m. There are deep crevices, suitable for breeding.	Excrement	

7	41,35406	64,25779	Double Concrete draining tunnels under the road	Length 20 m, height 2 m. There are deep crevices, suitable for breeding. t=34°C	***1 tunnel:*** *Eptesicus bottae* – It was not possible to extracted *Pipistrellus pipistrellus* – It was not possible to extracted ***2 tunnel:*** *Eptesicus bottae* – 37♀+2♂+16Juv *Pipistrellus pipistrellus* – 1♀+6♂+2?) (Ultra sound recording, hand-released)		
8	41,28174	64,26692	Double concrete draining tunnels under the road	Length 35 m, height 2 m. There are deep crevices, suitable for breeding. t=32°C	***1 tunnel:*** *Eptesicus bottae* – 8♂+1♀ *Pipistrellus pipistrellus* –3♂ ***2 tunnel:*** *Eptesicus bottae* – 6♂ *Pipistrellus pipistrellus* - 2 –♂ (Ultra sound recording, hand-released)		

9	41,52479	064,26850	Double concrete draining tunnel under the railway. On the opposite site: Double concrete draining tunnel under the road	Under the railway: length 8m, height 2m. There are deep crevices, suitable for breeding. t=34°C Drainage under road: length 24 m, height 1 m. There are deep crevices, suitable for breeding.	*Tunnels under the Railway:* **1 tunnel**: Empty **2 tunnel:** Eptesicus bottae - 11♀+19♂ *Tunnels under the Road:* Lots of excrement	
10	41,52538	64,27600	Double concrete draining tunnels under the railway. On the opposite site: Double concrete draining tunnels under the road	Tunnels under the railway: length 15m, height 2m. There are deep crevices, suitable for breeding. t=34°C Tunnels under road: length 24 m, height 1 m. There are deep crevices, suitable for breeding. t=35.5°C	*Tunnels under the railway:* ***1 tunnel:*** *empty* ***2 tunnel:*** *Eptesicus bottae* – 10♀+10Juv *Tunnels under the road:* ***1 tunnel:*** *Eptesicus bottae – 1♂* ***2 tunnel:*** *Eptesicus bottae* – 2♀+2♂	

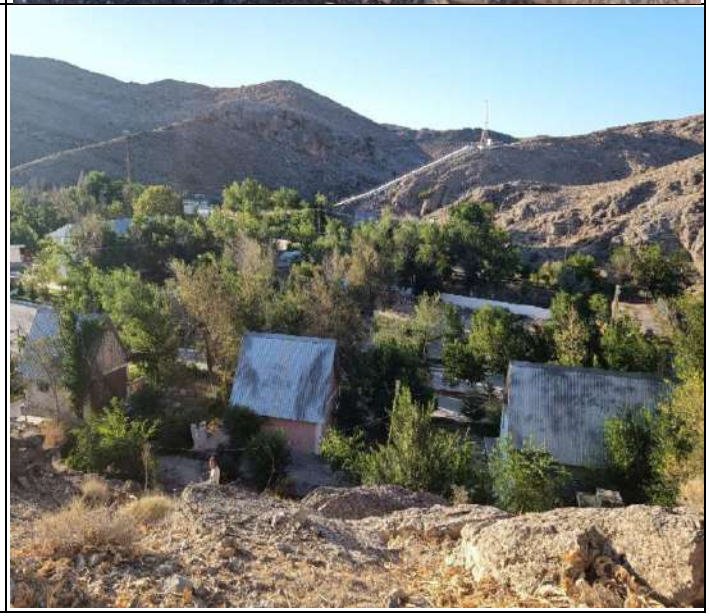
11	41,52443	64,30352	Double concrete draining tunnels under the railway. On the opposite site: Double concrete draining tunnels under the road	Tunnels under the railway: length 12m, height 2m. There are deep crevices, suitable for breeding .t=34°C Tunnels under road: length 23 m, height 1 m. There are deep crevices, suitable for breeding. t=30,9°C	*Tunnels under the railway:* ***1 tunnel:*** Empty, filled with water, the crevices are clogged with clay ***2 tunnel:*** *Eptesicus bottae* – 1 there was no way to extract Tunnels under road*:* ***1 tunnel:*** *Eptesicus bottae – 1♂* ***2 tunnel*** *–* *Empty*	
12	41,53070	64,33598	Concrete draining tunnel under the railway, On the opposite site: Concrete draining tunnel under the road	Tunnels under the railway: length 16m, height 1m Tunnels under road: length 23 m, height 1 m. In both cases there are crevices, however, most are plugged up. More as a temporary roost	Excrement	

13	41,52903	64,37927	Concrete draining tunnel under the road	Length 24 m, height 1 m. There are crevices, however most are plugged. More as a temporary roost	Excrement	
14	41,51681	64,42400	Concrete draining tunnel under the road.	Length 17 м, height 2 м. There are deep crevices, suitable for breeding. t=32,1°C	*Eptesicus bottae* – 8♂	

15	41,51227	64,42524	Concrete draining tunnel under the road.	Length 31 м, height 2 м. There are deep crevices, suitable for breeding. t=32,9°C	*Eptesicus bottae* –6♂	
16	41,50287	64,43111	Concrete draining tunnel under the road.	Length 19 m, height 2 m. There are deep crevices, suitable for breeding. t=33.6°C	*Eptesicus bottae* – 6♂+2♀+4?	

17	41,49735	64,43951	Concrete draining tunnel under the road	Length 26 m, height 2 m. There are deep crevices, suitable for breeding. t=33.9°C	*Eptesicus bottae* – 15♂+8♀+5Juv	
18	41,48505	64,45000	Concrete draining tunnel under the road	Length 17 m, height 2 m. There are deep crevices, suitable for breeding. t=34.3°C	*Eptesicus bottae* – 3♂+13♀+8Juv	

19	41.583432	64.321354	Mine galleries	The mine is dry, with humid air. Visited by people, inside the burnt torches and a burnt mattress were found. Total length is about 60 m. t=24-26.6°C	*Eptesicus bottae* –2♂	
20	41,56984	64,52186	Grotto	2x1.5 m input, depth no more than one meter.	Excrement	

21	41.536338	64.388816	Mine shaft	Mining gallery (vertical), it is impossible to descend and next to the ruins of the village with a mass of roosts (April). At the time of the visit in June, the mine was completely filled in.	Not detected	
22	41.557647	64.382591	Mine galleries	The " Cold Keys ", recreation canter, where, according to the survey data, there is a mine gallery with bat. However, during the visit to the area, it became obvious that the mine had been backfilled.	There are no mine galleries, however, there are many natural rock roosts (crevices)	

23	41,64522	64,43736	The Cave	The height is up to 2m 80 cm, width - 1.5 m. The total length is about 3 m. The temperature of the walls is 30.7°C.	The total number of recorded Common pipistrelle bat is 112.	

Appendix 2. Additional photographic material

Figure 11. Young Bokhara horseshoe bat (photo by Gritsyna M.)

Figure 12. A feeding female of Ognev's serotine bat (photo by Gritsyna M.)

Figure 13. Habitats of the bat. Tamdytau valley. (Gritsyna M.)

Figure 14. Habitats of the Bats (Chiroptera) Kyzylkum desert and Tamdytau remnant (photo by Gritsyna M.)

Figure 15.Habitats of the Bats (Chiroptera) Kyzylkum desert (photo by Gritsyna M.)

Figure 16. Habitats of the Bats (Chiroptera) Tamdytau remnant (photo by Gritsyna M.)

Figure 17. Smoothed crevices and cover of drains with resin (photo by Gritsyna M.)

Figure 18. Habitats of Bats (Chiroptera). Aktau mountain, Tamdytau (photo by Gritsyna M.)

Figure 19. Habitats of Bats (Chiroptera). Aktau mountain, Tamdytau (photo by Gritsyna M.)

Figure 20. Habitats of Bats (Chiroptera). Aktau mountain, Tamdytau (photo by Gritsyna M.)

Figure 21. Taking measurements (photo by Mun Yu).

Figure 22 Taking measurements (photo by Atakhodjaev A.).

Figure 23. Survey of draining tunnels (photo by Atakhodjaev A.)

Figure 24. Measurement of Bokhara horseshoe bat (photo by Mun Yu).

Figure 25.Examination of the mine gallery (Atakhodjaev A.)

Figure 26. Stretching the net on the cave in Aktau (photo by Atakhodjaev A.)(

Figure 27. Passages along the flow in the Aktau mountains (photo by Atakhodjaev A.)

Figure 28. The Ognev's serotine bat (Eptesicus bottae ognevi) in the draining tunnel (photo by Atakhodjaev A.)

Figure 29 The Ognev's serotine bat (Eptesicus bottae ognevi) in the draining tunnel (photo by Atakhodjaev A)

Figure 30. Female and pup of Bokhara horseshoe bat (photo by Atakhodjaev A.)

Figure 31. Examination of the draining tunnel (photo by A. Atakhodjaev)

Figure 32. Survey of natural habitats (photo by Atakhodjaev A.)

Figure 33. Examination of the draining tunnel (photo by A. Atakhodjaev)

Entomological survey

ZARAFSHAN WIND FARM PROJECT:
CLIENT: WOOD GROUP
Date: December 2020

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Contents

1. INTRODUCTION 2
1.1. HISTORY OF THE STUDY OF THE REGION 2
1.2. PHYSIOGRAPHICAL DESCRIPTION OF THE STUDIED AREA 3
1.3. CLIMATE, WATER, SOIL AND VEGETATION 5
2. METHODS TO CONDUCT HERPETOLOGICAL FIELD RESEARCH 6
3. RESULTS 7
4. ANNOTATED LIST OF REPTILES 9
4.1. INHABITING THE PROJECT AREA 9
CLASS AMPHIBIA 9
CLASS REPTILIA 10
4.2. FAUNISTIC COMPLEXES OF THE PROJECT AREA IN NAVOI REGION 32
4.3. OCTOBER 2020 FIELD EXPEDITION RESULTS 32
5. CONSTRUCTION-RELATED THREATS 33
6. RECOMMENDATIONS 33
Introduction 36
Results 37

1. INTRODUCTION

Uzbekistan is located in the central part of Central Asia and borders on four Central Asian countries – Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan, as well as Afghanistan in the south. Its geographical location at the junction of a number of biogeographic regions determines the age, diversity, origin and complex genetic relationships between the regional flora and fauna. The gene pool of wild animals inhabiting the territory of Uzbekistan is unique. The country is an important habitat for endemic species and subspecies of Central Asian animals. Most of it is represented by native fauna (Yunusov et al., 2015).

In the modern world, we are becoming increasingly more aware of sustainable nature management as the only correct way for the further development of mankind.

One of these approaches is the introduction and use of alternative energy sources.

It should be noted that Decree No. УП-5544 'On Approval of the Strategy for Innovative Development of the Republic of Uzbekistan for 2019-2021' issued by the President of the Republic of Uzbekistan on 21 September 2018 specifies that the share of electricity production using renewable energy sources will increase to at least 20% by 2025.

In addition, long-term targets for the development of RES and a plan for organizational and practical measures for further development of RES were approved in accordance with Decree No. ПП-4422 'On accelerated measures to improve the energy efficiency of economic and social sectors, the introduction of energy-saving technologies and the development of renewable energy sources' issued by the President of the Republic of Uzbekistan on 22 August 2019.

This decree determines an increase in the share of electricity production using renewable energy sources to at least 25% by 2030.

To achieve the targets, the government has developed a plan to build almost 10 GW of new renewable energy facilities, including 5 GW of solar (excluding the capacity of individual households), 3 GW of wind and 1.9 GW of hydroelectric power plants.

At the same time, the construction of new renewable energy facilities with a total capacity of more than 10 GW and the modernization of existing hydroelectric power plants will ensure the production of more than 37 billion kWh of electricity by renewable energy facilities (in 2018 – 5.9 billion kWh), as well as expected annual savings of more than 8.1 billion m^3 of natural gas.

This report provides a faunal overview of the area designed for the construction of wind power plants in Navoi region.

At this laboratory stage an overview of the fauna is provided based on literary, official and the authors' personal data.

1.1. HISTORY OF THE STUDY OF THE REGION

The history of the study of reptiles inhabiting the territory of Uzbekistan, as was the case with other vertebrates in Central Asia, began with the trip of E. A. Eversmann and K. Pander from Orenburg to Bukhara (October 1820 – April 1821). The few and occasional collections of E. A. Eversmann, transferred to the University of Berlin, were

processed by Prof. G. Lichtenstein and published in 1823 as an appendix to the work of E. A. Eversmann (Bogdanov, 1960).

A. P. Khoroshkhin left Jizzakh in April 1872 and drove along the foot of the Nuratau Range and past the Aristan-Beltau mountains, and arrived in Tamdy, from where he travelled to the Aktau and Bukantau mountains. However, A. P. Khoroshkhin was not a specialist and did not collect reptiles, and in the book published in 1876 he mentioned only a Russian tortoise, Caspian Monitor and Sand racer.

G. Ye. Grum-Grzhimailo travelled across Uzbekistan with his expedition in 1885 (see Fauna of the Uzbek SSR, vol. II). His collections were processed by A. M. Nikolsky (1915).

The book by A. M. Nikolsky 'Reptiles and amphibians of the Turkestan general-governorship,' a complete literary summary of that time, was published in 1899. The author processed the materials of A. P. Fedchenko and others who collected them in Central Asia. The paper provides information on the distribution of 7 species of amphibians, 3 species of tortoises, 42 species of lizards and 28 species of snakes. Of these, 2 species of amphibians, 1 tortoise species and more than half of the species of lizards and snakes were caught in the territory of Uzbekistan (Sultanov, Persianova, 1982).

In 1933, 1934 and 1935 A. M. Andrushko collected in the central part of Kyzylkum more than 700 individuals of reptiles. Her article published in 1953 lists 23 species and specifies their distribution across biotopes. 7 species of reptiles (Transcaspian bent-toed gecko, Turkestan thin-toed gecko, Reticulated toad-headed agama, Striped racerunner, Tatary sand boa, Spotted whip snake and Diadem snake) were for the first time discovered in this part of the desert.

O. P. Bogdanov in his work "Fauna of the Uzbek SSR. Amphibians and reptiles" (1960) provides data that he collected in Central Kyzylkum in 1949, 1950, 1954 and 1955.

N. N. Shcherbak (1974) studied racerunners (genus *Eremias*) throughout their habitat, including the central part of Kyzylkum, in particular, in the area near the towns of Zeravshan and Uchkuduk.

The publication of D. A. Bondarenko and E. A. Peregontsev (2017) describes the spatial distribution of the Russian tortoise *Testudo horsfieldii* in Uzbekistan, mostly in the central part of the Kyzylkum desert.

Also, this report presents the author's personal data collected during field studies of the area in 2012, 2014, 2015, 2018 and 2019.

1.2. PHYSIOGRAPHICAL DESCRIPTION OF THE STUDIED AREA

The Kyzylkum physiographical region (Fig. 1) is located almost in the very center of the flat part of Central Asia, which is associated with truly desert landscape. It includes the western part (belonging to Uzbekistan) of the Kyzylkum Desert (its northern and eastern parts are on the territory of Kazakhstan). In the north lies the border of the region with Kazakhstan, in the south-west – with Turkmenistan, in the east is the Mirzachul area, in the south-east – the Zeravshan area and in the west – the lower Amudarya area (Gulomov et al., 2013).

The surface of the area slopes slightly down from South-East to North-West. The average altitude above sea level is 200-300 m, in the South-East the heights reach 350-

400 m, in the north-west – only 100 m. The lowest point is the Mingbulak depression 12 m below sea level. The highest point is Aktau peak (922 m) in the Tamdytau Mountains (Gulomov et al., 2013).

The Kyzylkum Desert in the north-west is bordered by the Aral Sea, in the North-East by the Syr Darya, in the east by the spurs of the Tien Shan and Pamir Alai, in the south-west by the Amu Darya. The area of the desert is about 300 thousand square kilometers. (Yugai, 1964).

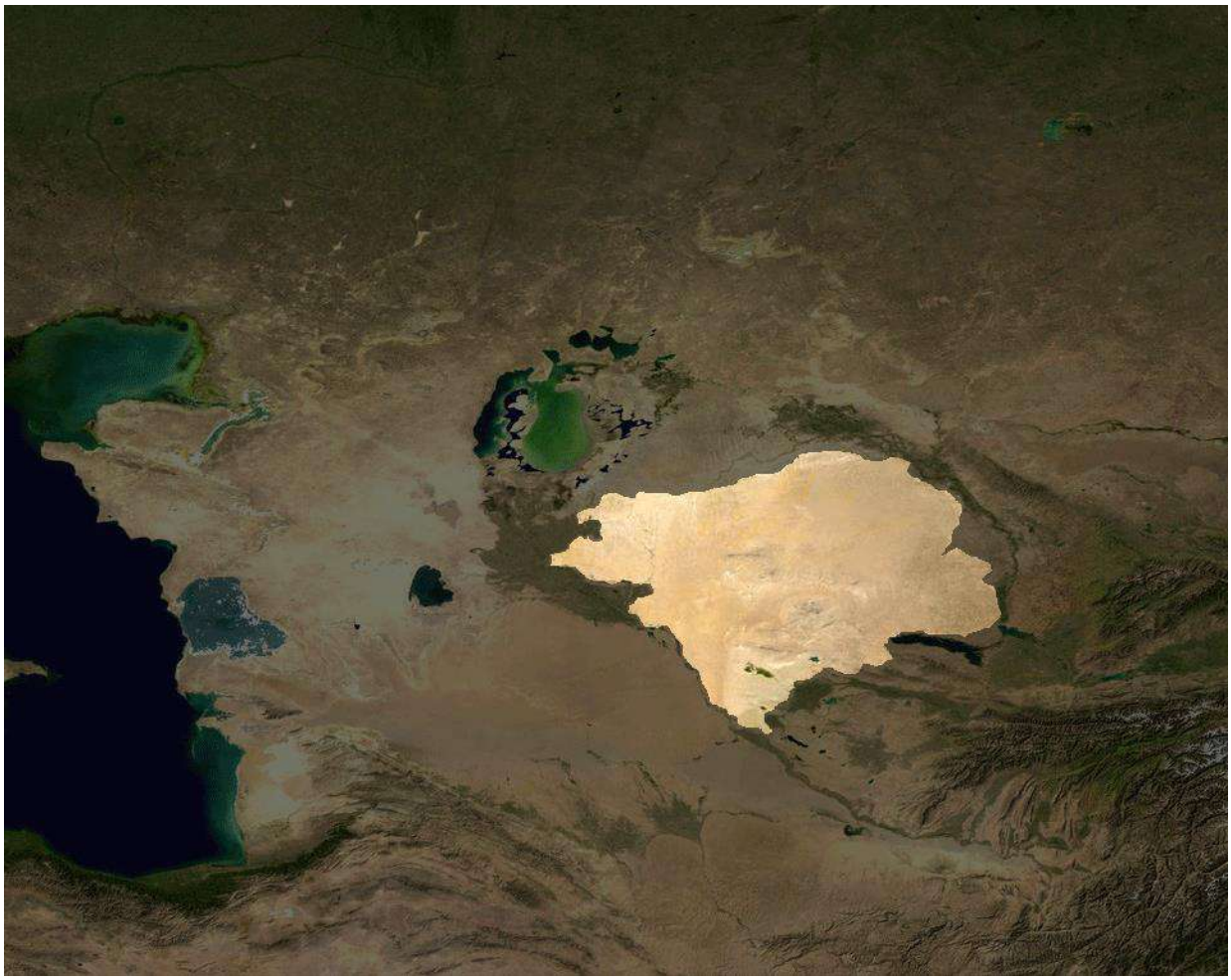

Figure 1 Satellite image with the territory of the Kyzylkum desert highlighted

The Kyzylkum Desert is a plain generally sloping to the north-west (altitudes above sea level range from 300 meters in the south-east to 53 meters in the northwest); it has a number of closed depressions and highly dissected isolated sky islands – Bukantau (764 m), Kuldzhuktau (up to 785 m), Tamdytau (922 m) and others, composed of strongly dislocated and metamorphosed Paleozoic shales, hornstones, limestones, granites. (Yugai, 1964). The mountains are barren and mostly have levelled peaks and rocky, heavily cut slopes. Between these mountains are the Mingbulak, Karakata, Mullali and Ayakagitma depressions. The lower parts of these depressions are occupied by *solonchaks*, *takyrs* and sands (Gulomov et al., 2013).

Most of the desert is occupied by extensive sandy areas composed of semi-fixed sands. The most widespread are meridionally-oriented sandy ridges. The relative height of the ridges is from 3 to 30 m, with a maximum of up to 75 m. The flat portions are composed of Cenozoic clays and sandstones, in the north and north-west – loamy and mixed sandy and loamy river sediments. A characteristic feature of the Kyzylkum desert

is the existence in its central and south-western parts of isolated low mountains – sky islands. These are Bukantau, Dzhetymtau, Tamdytau, Kuldzhuktau, as well as Sultanuizdag in the west. All of them are remnants of Paleozoic (Hercynian) folded chains located on the continuation of the structures of the northern chains of the Pamir-Alai (Turkestan and Nuratau Ranges) and formed by the latest tectonic processes. The elevations are composed of highly dislocated and metamorphosed Paleozoic slates, limestones and granites. The tops and crests of many of the sky islands have levelled surfaces used for unirrigated farming. The slopes of the sky islands are strongly dissected; at the feet there are aprons composed of pebbly and sandy accumulations, which often contain fresh groundwater and in some places feed the springs that supply mining villages with water. The area of the sky islands also features flat hilly elevations and plateaus of the cuesta type, composed of slightly disturbed Cretaceous and Paleogene sedimentary rocks (marls, sands, clays). Another characteristic feature is the existence of extensive closed basins (the Karakat and Ayakagytma basins) in the central and south-western parts of the desert (Gulomov et al., 2013).

Loose sand dunes are found near human settlements and around wells. In most cases, the exposure of the sands is the result of excessive grazing and trampling of vegetation by livestock near watering holes, as well as the use of shrubs and saxaul for fuel (Gulomov et al., 2013).

Sheep and goats, as well as camels and horses and, to a lesser extent, cattle graze in the Kyzylkum desert. The organization of pasture use and the creation of new wells made it possible to significantly increase the livestock population (Gulomov et al., 2013).

Large artesian basins were discovered in the central and south-western parts of the desert. Agriculture is beginning to develop near artesian wells in depressions, where melons and pumpkins are cultivated and experimental stations are established to provide livestock with additional feed (Gulomov et al., 2013).

1.3. CLIMATE, WATER, SOIL AND VEGETATION

The climate of the Kyzylkum physiographical region is arid and sharply continental. It is characterized by high summer temperatures, a very low level of annual precipitation and a strong fluctuation of daily and annual temperatures (Gulomov et al., 2013).

Winter in Kyzylkum is cold. The reason for this is the frequent invasions of dry and cold Arctic air masses and the Siberian anticyclone from the north. On such days, the air temperature drops sharply to –31–35 ° C. Western air masses bring precipitation and a slight increase in temperature. The average temperature in January in the north of Kyzylkum is –5–10 ° C, in the middle part –2–4 ° C, in the south –1–2 ° C (Gulomov et al., 2013).

With the coming of spring, the temperature gradually rises and rainfalls become quite frequent. Nature awakens and the earth becomes covered with ephemeral plants. The precipitation season is already over in April. In the long summer period (lasts more than 150 days), the air temperature is the same almost throughout. This is due to the large amount of solar radiation (total annual radiation is 120 kcal per 1 cm^3) and the penetration of hot tropical air masses from the south. The average temperature in the southern and central parts is + 30 °, in the north + 26 + 28 ° C; on some days the

temperature reaches + 48 ° C. At this time, the sands warm up to +75 + 80 ° C. Autumn in Kyzylkum is usually dry. There is little precipitation (up to 75–100 mm annually), and it is unevenly distributed over the seasons. The largest portion of the annual amount of precipitation falls in spring (up to 48%) and winter (up to 30%), but the evaporation rate reaches 1,000–1,500 mm (Gulomov et al., 2013).

The region has a significant stock of groundwater. The dynamic amount of groundwater is 58–60 m^3/sec. The groundwater is salty. Fresh artesian waters are available in the strata of the Mesozoic and Paleogene sediments. Also, mineral thermal waters were found in the Paleozoic deposits (Gulomov et al., 2013).

In Kyzylkum, sandy and mixed sandy and loamy soils are widespread in the plains, foothills and on the slopes of the elevations – grey-brown soils, and in the basins – solonchak and marshy solonchak soils (Gulomov et al., 2013).

More than 600 plant species grow in the Kyzylkum area. When the hot season sets in, they wither. Plants adapted to droughts and solonchaks continue to grow in summer (Gulomov et al., 2013).

2. METHODS TO CONDUCT HERPETOLOGICAL FIELD RESEARCH

During the field research an attempt was made to assess the status of reptiles and amphibians in the study area (specification of the species and quantitative composition, territorial distribution, including places of concentration, the state of habitats). However, it should be said that cold weather did not allow for a full survey in this area, while single records of reptiles do not give a complete understanding of the composition of the biodiversity in the area.

Therefore, the main method of collecting information was to search for data in literary and stock sources.

Field studies were carried out according to generally accepted zoological methods for identifying species composition. The following methodological guidelines were used in the survey: L. G. Dinesman, M. L. Kaletskaya (1978), V. M. Makeev, A. T. Bozhansky (1988) and N. N. Shcherbak (1989), D. A. Bondarenko, Chelintsev, (1996). Literature sources and statistical data had been processed.

The main research method used was mixed stationary and transect survey. Points and transects for conducting research were outlined at the project monitoring stations in accordance with different types of habitats.

The field research methodology reflects the following aspects:

- species composition in the study area;
- distribution across habitats;
- daily and seasonal changes in activity;

Thus, the method of quantitative assessment was based on the ecology of the species under consideration, landscape and geographical conditions, season and type of work.

The quantitative assessment of reptiles and amphibians was mainly based on the transect survey. The transect method consists in counting individuals along a fixed long line (transect), on both sides of it, with the duration of the survey determined by the known distance, which is selected depending on the type of reptile and the area, but does not exceed 1 km in one way. In this case, all individuals encountered on the transect are

registered, regardless of the distance they are identified at. The perpendicular distance is measured between the transect axis and each individual. The results obtained are used to calculate the density of recorded reptiles. The one-kilometer transect was chosen because heaviest errors arise when long transects are used for species that, like the Russian Tortoise, have high density, daily and seasonal activity cycles fluctuations with high peak values, and are caused by incorrect selection of a minimum survey area for a particular species (Vashetko et al, 2001).

The reptiles' population density (***D***) was calculated using the following formula (Bondarenko, Chelintsev, 1996):

$$\boldsymbol{D = \frac{n}{2LB}}$$

where ***n*** – number of animal individuals recorded on the transect; ***L*** – length of the transect; ***B*** – formula to calculate an effective width of the survey strip:

$$\boldsymbol{B = W(0,79F + 0,21F^4)}$$

where ***W*** – width of the limited strip on both sides of the transect axis; ***F****:*

$$\boldsymbol{F = \frac{2y}{W}}$$

Formula to calculate a relative statistical error ***e(D)***:

$$\boldsymbol{e(D) = \frac{1,25 + 0,1F}{\sqrt{k}}}$$

where ***k*** – number of records of individuals on the transect.

The use of perpendicular distances to carry out survey on a strip of limited width excludes underestimation of the population density of the reptiles caused by a decrease in their detectability in remote parts of the survey strip, regardless of the degree of its limitation (Bondarenko and Chelintsev, 1996).

The abundance of the reptiles in habitats is estimated using the following population density scale for 1 ha (Kuzyakin, 1962): 0.1 – 0.9 – rare, 1.0 – 9.9 – common, 10.0 and higher – abundant.

3. RESULTS

The list of the herpetofauna of the study area is based on the modern list of representatives of the amphibian fauna of Uzbekistan, consisting of 3 species from two families, and the list of reptile species of Uzbekistan, consisting of 62 species from 13 families.

It should be noted that the lists of these species are preliminary and based on the available literary and official data and, partially, the author's personal field observations. To reconstruct the existing situation, it is necessary to conduct focal field studies in the period of the highest reptile activity (April) and, based on the results, compile a complete lists of species and obtain comprehensive information on population statuses and reptile numbers for each of the affected areas.

According to processed information and the author's personal data, currently, the wind power plants construction site is inhabited by 1 amphibian species and 14 reptile species belonging to 8 families (Table 1). The total number of amphibian species comprises 25% of the total diversity of the amphibian fauna of Uzbekistan, reptiles – 22.6%. Among them, 6 species are included in the Red Book of the Republic of Uzbekistan (2019) (42.8% of the total number of species inhabiting the project area), 2

species are included in the Red List of the International Union for Conservation of Nature (IUCN Red List) (14.3% of total number of species inhabiting the project area) and 4 species – in the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (28.5% of the total number of species inhabiting the project area).

Table 1. List of reptile species inhabiting the project territory

No.	Species name	Species name acc. to literary sources	Author's earlier personal data	October 2020 field expedition data	Species abundance	Endemism	Nature conservation status		
							UzRDB	IUCN	CITES
Family Toads *Bufonidae*									
1	*Turan toad* *Bufotes turanensis*	**+**			Common	UZ, TJ, TM			
Family *Testudinidae*									
1	Russian tortoise *Testudo horsfieldii*	+	+		Common		2 (VU)	VU	II
Family *Gekkonidae*									
2	Southern Even-fingered Gecko *Alsophylax laevis*	+			Rare	UZ, TM	2 (VU:D)	CR	
3	Turkestan thin-toed gecko *Tenuidactylus fedtschenkoi*	+	+		Common	UZ, TJ, TM, KZ			
Family *Agamidae*									
4	Steppe Agama *Trapelus sanguinolentus*	+	+		Common				
5	Sunwatcher toad-headed agama *Phrynocephalus helioscopus*	+	+	+	Uncommon				
Family *Lacertidae*									
6	Rapid Lizard *Eremias velox*	+	+		Common				
Family *Varanidae*									
7	Caspian Monitor *Varanus griseus caspius*	+	+		Rare		2 (VU:D)		I
Family *Boidae*									
8	Desert sand boa *Eryx miliaris*	+			Rare		3 (NT)		II
9	Tatary sand boa *Eryx tataricus*	+			Rare		3 (NT)		II
Family *Colubridae*									
10	Sand racer *Psammophis lineolatus*	+	+		Common				
11	Spotted whip snake *Hemorrhois ravergieri*	+		+	Common				

12	Spotted desert racer *Platyceps karelinii*	+	+		Uncommon				
13	Derafshi Snake *Lythorhynchus ridgewayi*	+			Rare		2 (VU:R)		
Family Гадюковые змеи *Viperidae*									
14	Karaganda pitviper *Gloydius caraganus*	+			Uncommon				

Notes to Table 1: UzRDB– species/subspecies listed in the Red Data Book of Uzbekistan (2019) (CR – critically endangered; VU – vulnerable; NT – near-threatened); IUCN – species included in the Red List of the International Union for Conservation of Nature (VU - vulnerable; NT – near-threatened); CITES I, II – species listed in the appendices (I, II) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora; Endemism: AF - Afghanistan, KZ – Kazakhstan; TM – Turkmenistan; KG – Kyrgyzstan; TJ – Tajikistan; UZ – Uzbekistan.

4. ANNOTATED LIST OF REPTILES

4.1. INHABITING THE PROJECT AREA

CLASS AMPHIBIA

FAMILY BUFONIDAE

TURAN TOAD

***Bufotes turanensis* (Hemmer, Schmidtler & Böhme, 1978)**

Figure 2 Turan toad

The length of the body with the head is up to 140 mm. The upper side is light grey-olive or greyish-green with or without black spots. The male has an internal resonator under the skin of the throat. During the mating season, the male has black calluses on the first two or three toes of the forepaws. The inner edge of the tarsus has a longitudinal skin fold. The pupil is horizontal. The toes of the hind paws are partly interconnected with the help of the swimming membrane. The parotid glands (parotids) are well developed behind the eyes. The caviar has the form of cords.

This is an economically important species, which destroys harmful insects in huge numbers. Local people sometimes catch it to use in traditional medicine.

In February and March toads lead a diurnal lifestyle. At this time, they bask in the sun or mate and spawn in irrigation canals, puddles and swamps. They then switch to a nocturnal lifestyle, which lasts until late autumn.

In the flatland part of the range most toads begin to hibernate in late October or early November and often appear on the surface of the earth only in mid-February, but most of them finish hibernating in early March.

Wintering places are animal burrows and various cavities in the ground.

The Turan toad is most active during the spawning period, which begins in late February and lasts until late May.

Habitats are highly diverse. The Turan toad occurs in river valleys, on the plains, in the foothills, in various agricultural fields, vegetable gardens, in human settlements and deserts with any types of sources of water, even seasonal ones, available. They hide in the burrows of various rodents and cracks in the ground.

O. P. Bogdanov (1960) recorded this species in the central part of Kyzylkum. Our team observed the species in the central part of Kyzylkum near the city of Zeravshan and along the Muruntau-Zeravshan road in 2012 and 2014.

CLASS REPTILIA

FAMILY *TESTUDINIDAE*
RUSSIAN TORTOISE
Testudo horsfieldii kazachstanica Chkhikvadze, 1988

Figure 3 Russian tortoise.

This species is endemic to Central Asia, where it inhabits lowlands and foothills (except drifting sands). In addition to Southern Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan and Tajikistan, it is distributed in Northern and Eastern Iran, Afghanistan,

North-western China and Northern Pakistan (Ananyeva et al., 1998; Bogdanov, 1960, 1965).

Carapace length is up to 286.4 mm. The carapace is flat, slightly serrated at the rear edge. The indentation on its front edge is not deep. Each of the front paws has four claws. The forearm is covered with six to seven transverse rows of tile-like mails. On the back of the thigh there are several horny tubercles concentrated in one group. The horny mails of the carapace are usually monochromatic, yellowish or brownish-olive, sometimes with wide black spots, more pronounced on the plastron.

The Russian tortoise is a vulnerable species endemic to Central Asia, whose numbers are decreasing. It is included in the IUCN Red List [VU] and the Red Book of the Republic of Uzbekistan 2(VU) (2019) and listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

It inhabits both sandy and clayey deserts, plains, mountain slopes, depressions and valleys, gorges and mountain steppe up to 1,150 m above sea level (Dal, 1936, 1937). Rarely lives on agricultural lands – on the edges of irrigated and unirrigated fields, in vegetable gardens and orchards. Avoids places with dense grass cover, as well as areas grazed intensively by livestock.

Figure 4 Russian tortoise's habitats

This is a strictly diurnal species. In hot weather, it can be observed only in the morning and before sunset. In the middle of the day, animals hide from the heat in temporary shelters under shrubs, where they half burrow into the soil, into the holes of

rodents or those dug by themselves. During the day, tortoises are capable of covering from 120 m to 2 km. At night they burrow into shallow pits, sometimes remaining on the surface of the ground.

After the winter diapause, tortoises appear on the surface in March—early April, in warm winters and in the south of the range – in February. Mating begins a few days after their emergence. The breeding season is extended from late March to late May. Newly emerged tortoises with a shell 30—50 mm long remain under the ground during the winter and usually appear on the surface next spring.

They grow slowly. Tortoises become mature at the age of 10—13 years, when their carapaces reach 11 cm in length. In natural environment they can live for at least 30 years.

In June, when ephemeral vegetation dries, the Russian tortoise enters a period of estivation (summer dormancy), for which it digs holes up to 1 m long. In deserts tortoises disappear by the end of May, but in the mountains or on irrigated lands, single individuals may be recorded in June and even July. Much more often, estivation flows into hibernation (winter dormancy).

In certain areas in the southern piedmont plains of Tamdytau and the eastern piedmont plains of Dzhetymtau (Navoi region), the population density averaged 11.7 individuals/ha, with a maximum of up to 15.6 inds./ha; in the pebbly-gravelly-loamy piedmont plain – 12.31 inds./ha (avg. 7.63 ± 5.92 inds./ha); in the rest of the area it was rare. In the rugged rocky areas of low mountains (Aitymtau Mountains) the tortoise occurs mainly along valleys. The highest population density of the species is 4.14 individuals/ha, which was recorded in a gently sloping valley with eroded loamy slopes (Bondarenko, 1994).

In the steppe between Tamdy and Ayakuduk – 29.2 inds./ha were recorded – 26.4♂: 50.5♀: 23.1 juv (Vashetko, Nuridjanov et al., 2010).

The number of tortoises is subject to significant fluctuations (Bogdanov, 1965), which depend on winter and spring meteorological conditions, as well as the abundance of food in biotopes where the animals live. The cultivation of virgin lands, livestock grazing and the use of natural habitats by humans significantly impact the population.

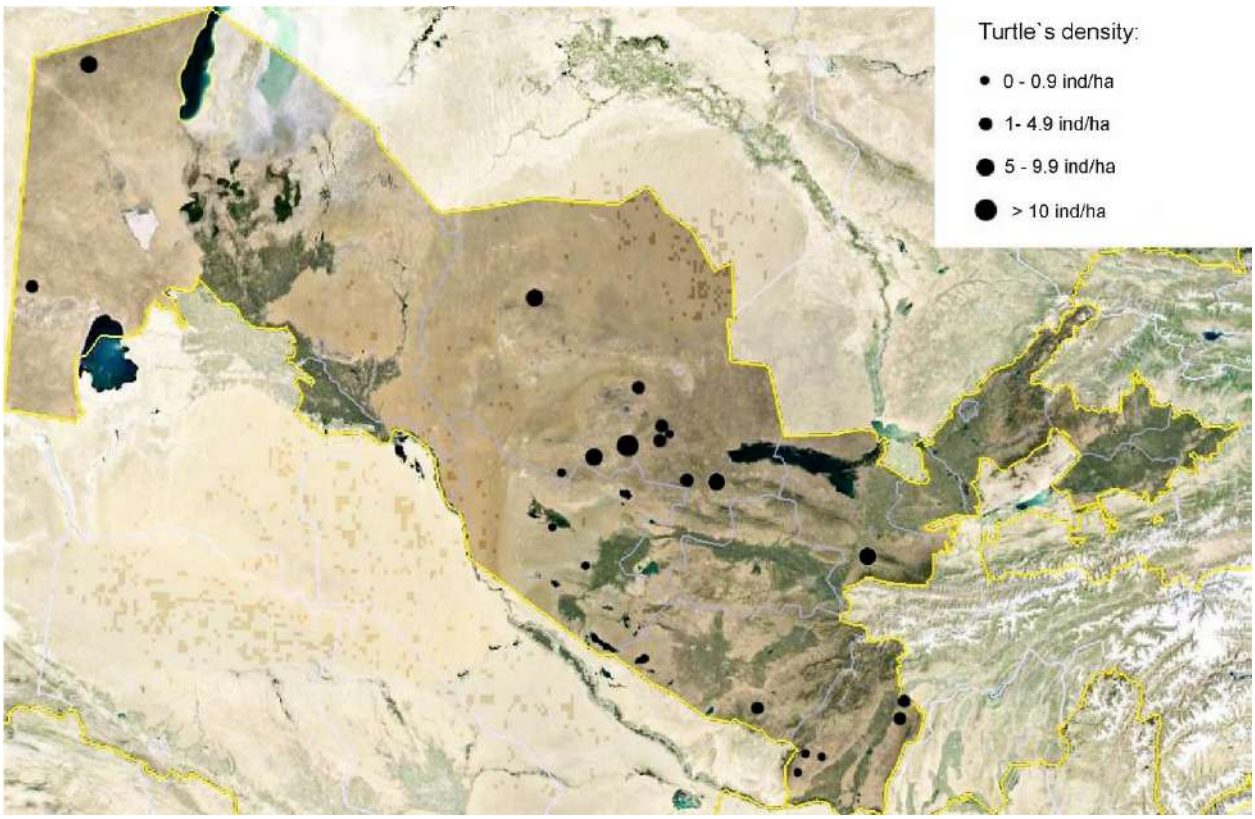

Figure 5 Map of the Russian tortoise population density in various parts of Uzbekistan

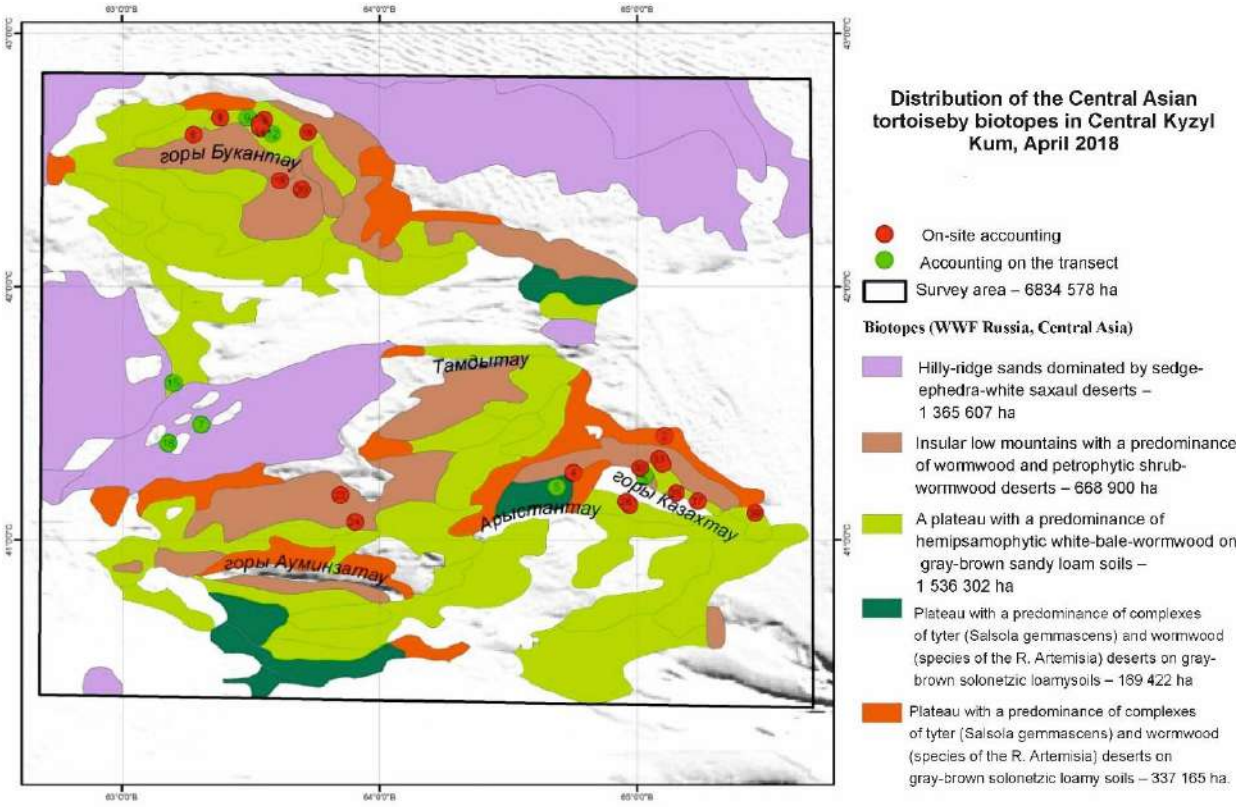

Figure 6 Map of the Russian tortoise's distribution across the biotopes of the central part of Kyzylkum (Data from the April 2018 field expedition)

Given below are the calculations of the Russian tortoise population density for the main identified biotopes of the central part of Kyzylkum based on the 2018 population census results:

the average density of the Russian tortoise on hilly and ridged sands is dominated by sedge, ephedra and white saxaul is 0.056 inds./ha, which, according to A.P. Kuzyakinu (1962), is quite low (Fig. 9), but generally typical of low-productive hilly and ridged sands.

Figure 7 Hilly and ridged sands dominated by sedge, ephedra and white saxaul

the average density of the Russian tortoise in low desert sky islands dominated by wormwood and petrophyte-shrub-wormwood communities is 15.08 inds./ha, which, according to A. P. Kuzyakin (1962), is a high indicator. It should be noted that this biotope is the most typical for this species (Fig. 10).

Figure 8 Low desert sky islands dominated by wormwood and petrophyte-shrub-wormwood communities (photo by M. A. Gritsina)

The plateau dominated by hemi-psamophytic saltwort (*Salsola arbuscula*) and wormwood communities on grey-brown sandy loam soils showed an average Russian tortoise population density equal to 4.4 inds./ha. This indicates a medium density in the given biotope (Fig. 11).

Figure 9 Plateau dominated by hemi-psamophytic saltwort-wormwood communities on grey-brown sandy loam soils

Figure 10 The plateau dominated by saltwort (Salsola gemmascens) and wormwood communities on grey-brown solonetzic loamy soils (photo by T. V. Abduraupov)

Not a single individual was found on the plateau dominated by saltwort (*Salsola gemmascens*) and wormwood (species from the genus *Artemisia*) communities on grey-brown solonetzic loamy soils (Fig. 12). Probably, the numbers in such areas are extremely low.

Alongside low desert sky islands dominated by wormwood and petrophyte-shrub-wormwood communities, the other most suitable biotope for the Russian tortoise is the aeolian plain with a thin layer of sand dominated by psammophyte-shrub-wormwood communities (Fig. 13). This is confirmed by the Russian tortoise's high population density in this area, which averages 22.5 inds./ha (Anduraupov et al., 2019).

Figure 11 The aeolian plain with a thin layer of sand dominated by psammophyte-shrub-wormwood communities

FAMILY GEKKONIDAE

SOUTHERN EVEN-FINGERED GECKO

Alsophylax laevis Nikolsky, 1907

Figure 12 Southern Even-fingered Gecko

Length of the body with the head: male – up to 31 mm, female – up to 33 mm (Figure 14). The head and body are slightly flattened from top to bottom. There are 16—20 scales across the forehead between the centers of the eyes. The upper side of the body is yellowish with a grey tint, with four indistinct, dark transverse, sometimes interrupting stripes on the back; similar stripes can be seen on the upper surface of the limbs and tail; in immature individuals the stripes are more contrasting. A wide dark longitudinal stripe extends from the tip of the muzzle across the eyes as far as the nape. There is a transverse stripe on the back of the head.

The Southern Even-fingered Gecko occurs on takyr with sparse vegetation, where completely barren and flat areas alternate with areas where short saltwort, clusters of wormwood and camel thorn and weak meadow grass plants grow.

This is a vulnerable, declining, sporadically distributed endemic species. Listed in the IUCN Red List [CR] and in the Red Book of the Republic of Uzbekistan 2 (VU: D) (2019). Endemic to Uzbekistan and Turkmenistan.

In the 1970s, there were from 0.3 (Ayakagytma depression) to 1,600 individuals (Kuldzhuktau sky island) recorded on 1 hectare in local populations; by now it has disappeared from many known habitats, while in others the number has sharply decreased (Bogdanov, 1992).

Southern Even-fingered Gecko is active from March to October at night, while during the day it hides in cracks in the ground, in its burrow or the hole of an insect or some other lizard. Mating takes place in March—April. In one season (from May to August) females produce 1–2 clutches each consisting of 1–2 eggs. The first young under 1 year of age are observed from mid-July; they become mature after wintering. It feeds on small insects and arachnids.

O. P. Bogdanov (1992) recorded it in the central portion of Kyzylkum, near the Kuldzhuktau sky islands and along the escarpments of the Ayakagytma depression. We recorded the species in small numbers at the foot of the Lau-Lau elevation: during a 3-hour night transect we encountered only 2 individuals. We also found one individual near a railway, at the Moilisay station not far from Uchkuduk.

TURKESTAN THIN-TOED GECKO
Tenuidactylus fedtschenkoi (Strauch,1887)

Figure 13 Turkestan thin-toed gecko

Length of the body with the head: newborns – 24 mm, males – up to 74 mm, females – up to 75 mm. The head is strongly and the body is noticeably flattened from top to bottom. The upper side of the body is brownish with a greyish tinge, with 4-5 dark irregular transverse stripes on the neck and body. There are also dark transverse stripes on the tail. The underparts are white, without spots.

It comes out of hibernation usually in March, often in February. At this time, Turkestan thin-toed gecko can be seen basking in the sun. In the hot season, it switches to an entirely nocturnal lifestyle. However, in the morning and evening hours, it leaves its shelter and takes sun baths. During the day, it hides in shelters or in the shade on vertical surfaces. It hibernates in the same crevices in which it hides in the daytime, at a depth of 20-30 cm. During the winter, it forms aggregations of 10-30 individuals in one place.

This is a biome species. In the wild, the Turkestan thin-toed gecko inhabits rocks located in mountain gorges, on loess vertical slopes, along the steep banks of seasonal mountain rivers. It often settles in urbanized habitats – on the walls of houses, where it forages for insects near lamps at night. This species often shelters in various cracks and crevices in rocks, precipitous loess slopes and between the bricks of buildings.

A. M. Andrushko (1953) recorded the Turkestan thin-toed gecko in the central part of Kyzylkum, where it was also caught by L. S. Barshchevsky (A. M. Nikolsky, 1915). T. Z. Zakhidov (1938) observed it in the south-eastern portion of Kyzylkum, in the Kukcha and Kazakhtau mountains. We repeatedly recorded it in the Aktau and Kazakhtau mountains. This is a fairly common species which lives on a horizontal surface.

FAMILY AGAMIDAE

STEPPE AGAMA

Trapelus sanguinolentus aralensis (Lichtenstein, 1823)

Figure 14 Steppe Agama

This is a medium-size lizard. The total length of the steppe agama does not exceed 300 mm, with the length of the body with the head up to 120 mm and the tail 1.3—2 times longer than the body.

Steppe Agama inhabits sandy, clayey and stony deserts and semi-deserts, preferring areas with shrubby or semi-woody vegetation. It is also found on gentle rocky slopes in the foothills, along the edges of loosely fixed sands, along river banks and in tugai, along the edges of human settlements and roadsides. It shelters in the burrows of gerbils, sousliks, jerboas, hedgehogs and tortoises, cavities under stones and cracks in the soil. In the hot season, agamas often climb on the branches of shrubs, thus protecting themselves from overheating on the soil heated by the sun. Males survey their site from an elevated position, protecting it from the invasion of competitors. After wintering, these lizards appears in mid-February, March or early April, depending on the weather at that time. Males leave their winter shelters earlier than females.

In Uzbekistan, it is widely distributed in arid zones. M. N. Bogdanov (1882) recorded this species in Kyzylkum, A. M. Andrushko (1953) observed it in the central part of the desert and T. Z. Zakhidov (1938) – in its southern portion. The Central Asian State University has the collections of T. Z. Zakhidov from the villages of Kok-Tepe and Tamdy, the Aydar solonchak and Ayak-Kuduk. The Institute of Zoology, Russian Academy of Sciences, keeps items collected by A. N. Kirichenko and E. S. Kiryanova 44 km west of Dzhengeldy, near the wells of Del-Kuduk, Akbay, and Ayak-Agitma and the Sar-Dala area (Bogdanov, 1960) and an individual caught by V. Pelts in Kepel. O. P. Bogdanov (1960) observed Steppe Agama in the Kyzylkum desert near Dzhengeldy, Ayak-Agitma, Kenimekh, Ayak-Kuduk, Tamda and Kyariz and all along the roads between these locations.

We observed this species almost throughout the central part of Kyzylkum. The average density during the period of the highest activity (April, May) in this area is 1.8—

2.3 inds/ha, in summer 0.2—0.3 inds/ha. On the fixed sands in the vicinity of the Tamdy village the density of the Steppe Agama during the period of highest activity is 2.7—3.4 inds./ha. In the vicinity of the village of Tamdy-Truba, where Steppe Agama lives in tamarisk thickets near a self-flowing well, the average density during the period of highest activity is 0.6—1.2 inds./ha. On the fixed sands in the vicinity of the village of Uzunkuduk, the average population density during the period of highest activity is 2.2—2.5 inds./ha. In the Yamankum sands, where it inhabits semi-fixed hilly sands overgrown with saxaul and sand acacia along unpaved and asphalt roads, the average density during the period of highest activity is 0.5—0.8 inds./ha.

The species' status in the territory of Uzbekistan causes no concern.

SUNWATCHER TOAD-HEADED AGAMA
Phrynocephalus helioscopus sergeevi Solovyeva, Dunayev & Poyarkov, 2012.

Figure 15 Sunwatcher toad-headed agama

The length of the body with the head in newborns is 18–25 mm, males – up to 57 mm, females – up to 62 mm. The upper surface of the muzzle drops at the front, which descends almost vertically to the lips. When viewed from above, the nostrils are not visible. The tail, flattened and widened at the base, abruptly becomes thinner and round in cross section. The colour of the body and the pattern are very variable: the upper side varies from ash-grey to dark grey or brown-grey and has transverse dark brown, brown or black spots. These spots are poorly developed or sometimes absent. On the upper surface of the neck there are 2 small, more or less oval red or pink spots, with blue or light blue fringes. The tops of the tail and limbs are often covered with transverse spots and stripes.

The first individuals of the Sunwatcher toad-headed agama appear in early March after wintering. The last ones were recorded in November before the winter. It is active in the daytime throughout the warm season.

It sometimes rises to foothills up to 778 m above sea level. Prefers hard soils with sparse vegetation.

This is an economically important species.

M. N. Bogdanov (1882) was the first to record the species in Kyzylkum. A. M. Andrushko (1953) observed it in the central part of the desert in the vicinity of Tamdy. A. N. Kirichenko and E.S. Kiryanova (Institute of Zoology, Russian Academy of Sciences) caught an individual in the Sar-Dala area, on the road from Ayak-Agitma to Tamdy, 2 km north of Tashrabad, between the wells Del-Kuduk and Bakhan-Kuduk, 13—18 km west of Tamda; M. M. Ostapenko (Institute of Zoology and Parasitology, Academy of Sciences of the Uzbek SSR) – at the Urkan well (Kenimekh District).

We repeatedly recorded it in previous field trips in the study area. In the latest expedition this was one of the few reptile species that we managed to see (4 individuals).

FAMILY LACERTIDAE

RAPID RACERUNNER
Eremias velox velox (Pallas, 1771)

Figure 16 Rapid Racerunner

The length of the body with the head is up to 84 mm (males) and up to 81 mm (females). In juveniles, three even black-brown or black stripes run along the back, with the central one forking on the neck; one stripe of the same colour with light round spots on it can be found on each side of the body. In adults (the main background of the upper part of the body is grey or sandy, often with an olive or brown tint) these stripes break into separate spots, while the sides of the body display light, black-edged, rounded spots, which in the front part of the body (especially in males) turn blue. It should be borne in

mind that the pattern of this lizard varies greatly from individual to individual. The belly and throat are white. In juveniles, the bottom of the tail and sometimes the small scales on the thighs and legs are red or red-orange.

Economically significant species. One of the most widely distributed and abundant species of Racerunners in the Palaearctic. It is widespread on the territory of Uzbekistan.

After hibernation, first individuals appear in the second half of March, most of them in early April. Hibernation begins in late October—early November. In summer, they are active mainly in the morning and evening hours.

In Uzbekistan, Rapid Racerunner is a typical inhabitant of river valleys, where it is most abundant. However, it also occurs in a wide range of other biotopes, which it inhabits depending on the presence of other species of Racerunners.

In the central part of Kyzylkum this species was recorded by A. M. Andrushko (1953), in Bukantau – M. D. Bogdanov (1882), in Ayak-Agitma – G. Lichtenstein (acc. to Bogdanov, 1960). In the Central Asian State University we examined the collections of G. Lichtenstein, also from Ayak-Agitma, Niyaz-Kuduk, Kel-Kuduk and Temir-Kuduk. Previously, we repeatedly observed this species in the study area. The average density there is 2.7—3.8 inds./ha.

FAMILY VARANIDAE

CASPIAN MONITOR
Varanus griseus caspius (Eichwald, 1831)

Figure 17 Caspian Monitor

Rare species. UzRDB (2019): 2 (VU:D).

The largest lizard in Uzbekistan and neighboring countries. The length of the body with the head is up to 520 mm. The upper side of the body is greyish-brown, yellowish-brown or reddish-brown, with numerous dark dots and specks. On the upper side of the neck there are two or three longitudinal brown stripes, and on the back and tail there are several transverse stripes of the same colour. In youngsters, the stripes are very pronounced, they are black or almost black.

After hibernation, the first individuals appear relatively late – in early to mid-April. Active all day throughout April. In May, they are active in the morning and evening hours. They go into hibernation in September-October. Often the Caspian Monitor has an estivation in summer, which gradually turns into winter hibernation. They begin estivating in late June—early July.

It inhabits mainly fixed and semi-fixed sands, clay and stony-gravelly soils, visits solonchaks. Sometimes it is found in the foothills of sky islands up to 1,000 m above sea level. M. Andrushko (1953) recorded the species in the central part of Kyzylkum. T. Z. Zakhidov (1938) reports that the Caspian Monitor often occurs in the northern part of the Kenimeh desert. According to the oral report from one of the workers of the anti-plague station, Akhmedov Isomiddin, it is quite often observed near the town of Zeravshan, especially to the west, north-west and south-east of it. We also repeatedly recorded it near the Bukantau and Auminzatau sky islands, as well as along the Muruntau-Zeravshan road in 2012, 2014 and 2019.

FAMILY BOIDAE

DESERT SAND BOA

Eryx miliaris (Pallas, 1773); *ssp. miliaris* (Pallas, 1773)

Figure 18 Desert sand boa

A medium-size snake. Females reach 720 mm in length, males are somewhat smaller – 550-580 mm. Tail length – 50-70 mm. The tail is short and blunt.

Desert sand boa is a near-threatened, sporadically distributed subspecies, included in the Red Data Book of the Republic of Uzbekistan (2019) with the status 3(NT); also included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

It lives mainly in sand deserts, where it prefers drifting and semi-fixed dunes, as well as more or less loose soils in deserts and semi-deserts with wormwood-saltwort communities and saltwort populations. It is less common on takyrs with patches of vegetation near sands and on relatively hard loess and clay soils, near ruins, on the slopes of gullies and at the borders of irrigated lands. Often occurs near colonies of Gerbils, whose burrows it uses to shelter. It is able to plunge into the sand quickly, head

first, and "swim" under its surface, leaving a characteristic trail in the form of a serpentine bulge. The upward-looking eyes allow the Desert sand boa to examine the surface without raising its head above the sand.

Active from April to October. In the hot season, it leads a nocturnal and crepuscular lifestyle. It uses the holes of rodents as a refuge, therefore it often settles in colonies of Gerbils. The breeding season is in late March. In June-July, the female gives birth to 4—10 babies up to 12—14 cm long. It feeds on lizards, rodents and small birds.

M. N. Bogdanov (1882) encountered this species in the sands of the Kyzylkum desert. A. M. Andrushko (1953) recorded it in the central part of the desert, and T. Z. Zakhidov (1938) – in the Kenimeh desert. Kh. S. Salikhbayev caught this snake in the Shafrikan forestry enterprise (leskhoz) near Barat-Kuduk (Bogdanov 1960).

In the 1950s, up to 20 individuals from the local population were recorded on a three-hour transect in Bukhara region (Shafrikan leskhoz).

In 2014 and 2016 our team recorded the Desert sand boa in the central part of the Kyzylkum desert, in the Yamankum sands, where it inhabits semi-fixed dunes. The average density of this species during the period of the highest activity in the Yamankum sands is 0.3–0.4 inds./ha. The average density during the period of the highest activity in the Kyzylkum desert is 0.2—0.3 inds./ha.

Currently, the population is rapidly decreasing due to increased poaching (the species is used in traditional medicine), high export and cultivation of lands.

TATARY SAND BOA

Eryx tataricus (Lichtenstein, 1823); *ssp. tataricus* (Lichtenstein, 1823)

Figure 19 Tatary sand boa

A medium-size snake. Females reach 1,050 mm, with a tail 60-70 mm long; the body length in smaller males is 950 mm, with a tail 70-80 mm long; females are usually 5-10 cm longer than males. The tail is blunt, rounded. The Tatary sand boa is a near-threatened, sporadically distributed subspecies, included in the Red Data Book of the

Republic of Uzbekistan (2019) with the status 3(NT) and Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The habitats are clay and loess deserts, semi-deserts and foothills, hillsides with ephemeral vegetation, stony-gravelly foothills with shrub thickets, open steppes with wormwood-saltwort communities. It also occurs on sandy soils – in depressions between dunes, on weakly fixed dunes, less often on thin sands. In some places it is also common on cultivated lands – in orchards, vegetable gardens and fields. In the mountains it rises to 1,500-1,600 m above sea level.

Active from March-early April to October-early November. In the hot months, it leads a nocturnal and crepuscular life, hiding during the day in the holes of rodents, tortoises and other burrowing animals, in cavities under the roots and lower sprouts of shrubs. It can submerge into dry sand and move a considerable distance under it. The breeding season is in late March-April. In July-August, the female gives birth to 10-21 babies, which reach up to 20 cm in length. The Tatary sand boa feeds on lizards, rodents, small passerine birds and insects.

A. M. Andrushko (1953) recorded the species in the mountains and gravelly plains of the central part of the Kyzylkum desert. A. N. Kirichenko and E. S. Kiryanova caught an individual in Shafrikan District (Bogdanov 1960).

Despite numerous expeditions, we have not found this species in the central portion of Kyzylkum, in particular, in the Tamdytau, Kuldzhuktau and Bukantau mountains. We suppose the abundance of the Tatary sand boa in the study area is low. The density during the period of the highest activity in the areas of the central portion of Kyzylkum most inhabited by the species is not more than 0.1-0.2 inds./ha.

Currently, the population is decreasing due to increased poaching (the species is used in traditional medicine), high export and cultivation of lands.

FAMILY COLUBRIDAE

SPOTTED WHIP SNAKE
Hemorrhois ravergieri (Menetries, 1832)

Figure 20 Spotted whip snake

Body length with the head is up to 1,180 mm; the number of abdominal scales in males is 202—213, in females – 207—224; the number of scales on the tail in males is 90–103, in females – 86–99. The head contrasts with the neck. The tip of the muzzle is bluntly rounded. The upper side of the body is grey with a brownish or yellowish tinge. Along the back there are a number of dark (to black) transverse stripes or spots, between which there are a number of smaller spots on the sides of the body. Oblique dark stripes run on the sides of the head from the eyes to the corners of the mouth; other stripes can be found under the eyes. The belly is light, often with occasional small specks. In Central Asia, black-headed individuals (both males and females) and almost black ones occur alongside those with typical coloration. There are also individuals that have an almost one-colour body, without spots or stripes. This snake displays one of the most variable coloration in Central Asia.

This is an economically important species.

After hibernation, it appears in the second third of March. At this time, it is observed on the surface only in the afternoon. In April-May, the Spotted whip snake becomes active in the morning and evening hours. In September, the snake is again active in the middle of the day. In October it begins hibernating.

Typical habitats for this species are foothills abounding in gullies or colonies of rodents, as well as precipitous slopes bordering river floodplains and human settlements in foothills and mountains. It is less common in piedmont clay desert.

One of the most abundant and widespread snakes in Uzbekistan. A. M. Andrushko (1953) recorded it in the mountains and gravelly plains of the central part of Kyzylkum. The species was also found in the study area during a field trip in October 2020. It was also shot by a camera trap installed in Tamdytau.

SPOTTED DESERT RACER
Platyceps karelinii (Brandt, 1838)

Figure 21 Spotted desert racer

A very thin snake of medium size with a relatively long tail: females have a body up to 865 mm long, tail up to 270 mm long; the body of males is up to 680 mm long and tail up to 235 mm long. The tip of the muzzle is sharpened. The head is slightly contrasting with the body.

The coloration of the upper side of the body is light ash-grey with a yellowish or brownish tint. One row of narrow black or blackish transverse stripes runs along the back, stopping 1-3 scales short of the abdominal mails. Towards the rear of the body the stripes become narrower, sometimes completely disappearing on the tail. Each of the intervals between these stripes on the sides of the body is filled with one row of spots extending into the dorsal mails. In the temporal area (from the outer edge of the mail on the top of the head to the corner of the mouth) there are roughly oval black spots. The ventral side of the body is light, yellowish or yellow, without spots. The underside of the tail is pinkish or light red.

The biotopes of the Spotted desert racer are associated mainly with the plain, where it is found in all types of deserts. It inhabits takyr-like and hard soils with wormwood, milkvetch and camel thorn and sometimes spreads into low foothills. In spring it is active during the daytime, while from June to August it becomes active at twilight and night and in the morning. After wintering, first active snakes are observed in the last third of February, while most of them appear in early April. Autumn activity continues until late November.

A. M. Andrushko (1953) recorded the species in the central part of Kyzylkum. We did not encounter any individuals.

DERAFSHI SNAKE
Lythorhynchus ridgewayi Boulenger, 1887

Figure 22 Derafshi Snake

Threatened, locally distributed species, which is rare in the wild. Listed in the Red Data Book of the Republic of Uzbekistan (2019), where it has the status 2(VU: R).

This is a small snake with a body 360-400 mm long (males) and 300-350 mm (females) and a tail 50-70 mm long. It differs from all other snakes in the fauna of Uzbekistan and neighboring countries by the unusual shape of the head – the muzzle is pointed heavily and protrudes forward above the mouth opening, which is typical for colubrid burrowing snakes.

The upper part of the body is light yellowish, sandy or dark brown. The back is covered with 35-45, and the tail with 10-14 elongated transverse oval light brown or brown spots, bordered with white fringes. A narrow light stripe of whitish scales stretches along the ridge. On each side of the body there is one row of smaller, light, rounded spots forming a chequered pattern with the dorsal spots. On the upper surface of the head there is a complex brown pattern resembling an anchor in form. The belly is white, without spots.

Typical biotopes are dry foothills, clay plains and levelled sandy areas (sandy semi-deserts and deserts), where this snake inhabits areas adjacent to takyrs and hard loamy soils with occasional tree-like saltworts and wormwoods. It lives under stones, in cracks in the ground, in the holes of lizards and rodents; often occurs in termite nests, which the snake uses to penetrate deep under the ground. Derafshi Snake uses an interesting method to dig burrows for itself: it drills into the soil with its sharp head, then bends the head to the side and uses it like a hook to scoop the soil out of the hole.

An extremely secretive snake, active at twilight and night. In spring, like many other nocturnal snakes, Derafshi Snake appears on the surface during the day after rainfall to bask in the sun. It leaves its winter shelters in late February-early March and remains active until late October-early November, when this snake enters a state of hibernation.

Only a few records of this snake have been made on the territory of the Republic of Uzbekistan. D. A. Bondarenko (1990) reports about two encounters in the central part of Kyzylkum: the first took place in late May 1981, when an individual was found at low

altitudes in the Aitymtau mountains, 6-10 km from Uchkuduk; the second one occurred on May 18, 1988, in the foothills of the Bukantau sky islands.

SAND RACER
Psammophis lineolatus (Brandt, 1838)

Figure 23 Sand racer

The length of the body with the head is up to 840 mm (males) and up to 710 mm (females). The number of abdominal scales – 181—204, sub-caudal scales – 83—105 pairs. The body is thin. The upper surface of the muzzle is concave, with a longitudinal groove. The upper side of the body is olive-grey or sandy-grey, the edges of the scales are lighter than their central parts; four dark stripes run from the head along the body; in some individuals, only traces of these stripes in the form of dark or black lines along the scales may remain. Sometimes the pattern on the body is missing. The belly is white with greyish, brownish or olive-grey spots, larger at the front of the body.

Single individuals appear after hibernation in February. Most of them emerge in late March-early April. At this time, the snakes are active all day. In May, the activity is observed in the morning and evening hours. They go into hibernation in October-November.

The sand racer inhabits all lowlands, from where it penetrates into foothills up to 1,100—1,200 m above sea level; however, it prefers more fixed and drifting sands, pebbly plains, mountains and broken grey soils near settlements. The sand racer is more often observed in places where areas with dense vegetation alternate with open patches. Therefore, in places with dense vegetation, it can always be found on low precipitous slopes, mounds and so on.

M. N. Bogdanov (1882) recorded this species in Kyzylkum, A. M. Andrushko (1953) – in the central portion of the desert, A. P. Khoroshkhin (1876) – all across the section from Temir-Kuduk to the Balta-Saldyr well. B. Mombetzhumaev (Institute of Zoology and Parasitology, Academy of Sciences of the Uzbek SSR) caught an individual at the Chaban-Kazgan well (north-western part of Kyzylkum); the author of this report – in Dzhengeldy, 30 km from Dzhengeldy towards the Metambay well; A. N. Kirichenko and E. S. Kiryanova (Institute of Zoology, Russian Academy of Sciences) – 44 km west of Dzhengeldy, in the Sary-Dag area on the road from Ayak-Agitma to Tamdy, 10 km from Kuzum-Kenderli (Bogdanov, 1960). We repeatedly recorded this species of snakes in the study area.

FAMILY VIPERIDAE

KARAGANDA PITVIPER

***Gloydius caraganus* (Eichwald, 1831)**

Figure 24 Karaganda pitviper

The body is small – usually up to 70 cm long. The overall coloration is grey, brown; the back has wide dark spots on it, often with black fringes. A number of smaller dark spots run along the sides of the body. A clear spotted pattern is visible on the top of the head, and a dark stripe runs along the side behind the eye.

These snakes live in steppes, clay and pebble deserts, foothills and mountains, rising up to 3,000 m above sea level. They shelter in crevices between stones, the burrows of Yellow Ground Squirrel and other rodents; they often inhabit cemeteries, ruins of buildings and river banks.

They usually hunt after sunset and are active until the morning. However, in early spring and autumn, they are active during the day.

N. A. Zarudny (1914) and M. N. Bogdanov (1882) recorded this snake in Kyzylkum, where the specialists found it in the Bukantau and Ilder-Ata mountains, on the takyrs. T. Yadgarov and B. Rajabov report that in April-May 1973 -1974 they caught 7 individuals of the Karaganda pitviper in the Bukantau mountains.

Although we have had numerous expeditions into the central part of Kyzylkum, in particular, into the Bukantau mountains, we have not found this species there. We suppose the abundance of pitviper in the study area is low. The density during the period of the highest activity in the Bukantau mountains is not more than 0.15-0.2 inds./ha.

The status of the species on the territory of the Republic of Uzbekistan does not cause concern.

4.2. FAUNISTIC COMPLEXES OF THE PROJECT AREA IN NAVOI REGION

Each of the types of habitats in the study area is characterized by a specific set of species – a faunal complex of amphibians and reptiles that has formed historically in the area. Each species is adapted to a specific set of environmental factors and this determines its relationship with specific ecosystems and habitats. Within any faunal complex, two groups of species can be distinguished:

1. Species closely related to a limited set of environmental factors (stenobiontic species). These are species characteristic only of a particular type of habitat. When the combination of conditions is favourable, the characteristic species can be quite numerous and common. Any change in habitat conditions negatively affects the distribution and population status of the characteristic species. Therefore, they are indicators of the degree of how natural habitats are conserved/disturbed. In the project area, these mainly include biome species (Turkestan thin-toed gecko, Desert sand boa and Karaganda pitviper), semi-aquatic species (Turan toad) and endemics – Southern Even-fingered Gecko, the last, like many species from this group, classified as rare and threatened.
2. Species that can adapt to a wider range of habitats (eurybiontic species). This determines their wide distribution and occurrence in various types of habitats, higher resistance to anthropogenic impacts. Many species from this group are economically important, can reach high numbers and serve as food for predators, including rare species. Such species inhabiting the project area include the Rapid Racerunner and Spotted whip snake.

In addition to these faunistic complexes, it should be noted that synanthropic species of reptiles live in territories near the villages, to which the Spotted whip snake can be referred. The rare Caspian Monitor (UzRDB, 2019) and the Sand racer forage occasionally in villages. Rapid Racerunner and Steppe Agama, Spotted desert Racer and Sand Racer inhabit heaps of soil taken from canals and ditches along fields, as well as precipitous slopes and the territory along them.

4.3. OCTOBER 2020 FIELD EXPEDITION RESULTS

The field trip to the project area was carried out from 19 to 21 October 2020. A part of the field research into the herpetofauna of the area was to be completed within the frames of this trip. However, cold weather prevented us from making a comprehensive survey in this area. The survey data do not correspond to the actual status and species

composition of the herpetofauna in this territory, because reptiles came to the surface only in short intervals of warm weather. A more detailed survey of amphibians and reptiles in the territory should to be conducted in an appropriate period of time – in April.

Table 1 Results of the survey of reptiles obtained from the project area during the field expedition in October 2020.

#	Date	Species	Soil t˚C	Air t˚C	Humidity	Number	Length of transect in m	Abundance	Coordinates of the beginning of the transects.
1	20.10. 2020	Spotted whip snake *Hemorrhois ravergieri*	+17, 6	+22º	41%	1 oc	1,000	1 inds/ha	VP 04 N 41.593233˚ E 64.396317˚
2	20.10. 2020	Sunwatcher toad-headed agama *Phrynocephalus helioscopus*	+19, 5	+22º	39%	2 oc	1,000	2 inds/ha	VP 05 N 41.574902˚ E 64.416759˚
3	20.10. 2020	Sunwatcher toad-headed agama *Phrynocephalus helioscopus*	+16, 9	+19	49%	1 oc	1,000	1 inds/ha	VP 09 N 41.614217˚ E 64.477953˚

5. CONSTRUCTION-RELATED THREATS

1. The cultivation of natural habitats for many species of reptiles (including rare and endemic ones) may cause the death of a part of the population;
2. Animals (insects, amphibians, reptiles, birds, mammals) can get into the pit and trenches dug for the construction purposes, which can lead to their injury and death. These trenches are especially dangerous for the Russian tortoise;
3. Changing the existing relief will lead to partial loss of the habitats for animals inhabiting the project area;
4. If the construction work is begun in the winter season, part of the population of reptiles (including rare ones) may die;
5. Linear structures connected to the construction site will also pose threat to the life of most reptiles, especially Russian tortoise and Caspian Monitor.

6. RECOMMENDATIONS

Safety and environmental protection must be priorities in any activity, for which it is necessary, after assessing potential threats, in this case to biodiversity, to make efforts to carry out activities aimed at minimizing potential damage. In this regard, we recommend the following actions:

1. Seasonality of work. The construction work must depend on the reptiles' activity. That is, it is advisable that all construction work should be carried out at a time when all reptiles have come out of hibernation (winter dormancy). In this period, reptiles do not have permanent burrows and can leave the construction site in advance. If the work is begun in the hibernation period, underground wintering chambers can be damaged and then the reptile is doomed to death.
2. Construction works must be carried out strictly within the territory designated for the purpose;
3. All trenches must be levelled (filled with earth) after the termination of the construction; trenches should not be used as barriers to protect the territory, so that animals should not be captured there;
4. When the construction stage is over, it is necessary to monitor regularly populations of terrestrial animals in the existing research sites within the project territory.
5. The so-called 'closed zones' (protected with a fence) must be organized in the territory of the objects, where no activity should be allowed. It would serve both a buffer zone of the object and, at the same time, a kind of protected area where animals can live undisturbed.

Herpetological survey

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Introduction

One major work, ‘Entomofauna of the south-western part of Kyzylkum’ (Davletshina et al. 1979), was dedicated to the study of the entomofauna in the territory of Tamdytau and Aktau. This work covers a large part of the Kyzylkum desert in Uzbekistan and provides a comprehensive study of the entomofauna. According to the authors, this territory is inhabited by 1,100 species from 16 genera and 108 families. This list is not ultimate, as is noted by the authors. However, afterwards no other research has been carried out in this field, this work thus remaining the only one covering the entomofauna of this region. There are no rare and endangered species in the list. The following researchers carried out general work on the entomofauna of Uzbekistan: A. G. Davletshina, A. A. Bekuzin, D. A. Azimov (1993); F. N. Pravdin (1978); Orthopterans – M. Zh. Medetov (2018); Hemipterans – A. N. Kirichenko (1951), V. F. Oshanin (1912); Termites – A. Sh. Khamraev, N. I. Lebedeva, K. Zh. Rustamov, T. I. Zhuginisov, G. S. Mirzaeva (2016); Coleopterans – Protsenko (1968), Lopatin (1961), G. V. Nikolaev (1987, 2002); Cockroaches – G. Ya. Bey-Bienko (1950); Mantis – I. I. Lindt (1953, 1955, 1961, 1963, 1968, 1977), F. N. Pravdin (1978); Phasmopterans – L. L. Mishchenko (1945); earwigs – G. Ya. Bey-Bienko (1936).

According to the latest edition of the Red Data Book of Uzbekistan (2019), the portion of the Kyzylkum desert around the construction site is inhabited by 8 rare and threatened species of insects and 1 spider:

Class – Arachnida

Order – Aranei

Family – Theridiidae

Genus *Latrodectus* Walckenaer, 1805

1. Dahl’s Black Widow - *Lathrodectus dahli* Levi, 1959 3(NT)

Class – Insecta

Order – Diptera

Family – Syrphidae

2. *Five-striped Flowerfly - Lathyrophthalmus quinquelineatus* Fabricius, 1781 2(VU:R)
3. *Ferula Flowerfly - Eumerus ferulae* Stackelberg, 1965 1(EN)

Order – Hymenoptera

Family – Crabronidae

4. *Pavlowskij's Digger Wasp - Kohlia pavlowskii* (Gussakovskij, 1952) 2(VU:R)
5. *Transcaspian Digger Wasp - Larra transcaspica* F. Morawitz, 1894 2(VU:R)

Family – Sphecidae

6. *Black-combed Digger Wasp - Prionyx nigropectinatus* (Taschenberg, 1869) 2(VU:R)
7. *Mournful Digger Wasp - Prionyx macula* (Fabricius, 1804) ssp. *lugens* Kohl, 1890 2(VU:R)
8. *Fadtschenkia Sapigid Wasp - Fedtschenkia indigotea* Radoszkowski, 1886 1(EN)

Order – Lepidoptera

Family – Noctuidae

9. *Tugay Underwing Moth - Catocala remissa* Staudinger, 1891 2(VU:D)

A. G. Akhmedov (2020) recorded 50 ant species in the territory, of which 1 species, *Tetramorium nitidissimum* Pisarski, 1967, was proposed for the inclusion into the next edition of the Red Data Book of Uzbekistan.

In addition to the Red Book species, it is worth mentioning the Turkestan Scarit *Anacanthotermes turkestanicus* Jacobson, 1904 inhabiting this territory: it can penetrate into various man-made structures and damage heavily their wooden elements. Apart from damaging wooden structures, termites can build nests under various reinforced concrete structures, causing their subsidence.

It is also necessary to mention fleas inhabiting the area, which transmit various infectious diseases. According to I. G. Ioff (1965), the territory is inhabited by about 12 flea species. The following flea species deserve special mentioning: fleas of gerbils – *Xenopsylla gerbilli* (Wagner, 1903), *Xenopsylla conformis* (Wagner, 1903), *Xenopsylla hirtipes* Rothschild, 1913, *Stenoponia vlasovi* Ioff et Tiflov, 1934; fleas of Yellow Ground Squirrel: *Citellophilus tesquorum* (Wagner, 1898), *Citellophilus trispinus* (Wagner et Ioff, 1926), *Neopsylla setosa* (Wagner, 1898). They are main transmitters of particularly dangerous infectious diseases. This is aggravated by the habitation of Yellow Ground Squirrel, Great Gerbil, Libyan and Mid-day Jirds in the study area, which transmit plague.

Results

According to the latest research, the entomofauna of the area is quite poor: we did not encounter any rare or Red Data Book species, while those we recorded are quite common for the desert. According to literary sources, the Red Data Book arthropods inhabiting the territory include Dahl's Black Widow - *Lathrodectus dahli* Levi, 1959, status 3(NT). More information can be obtained, if one more research expedition is organized in spring. According to a preliminary analysis, the creation of a wind power plant would not impact the entomofauna of the region. Given below is a table (Table 1) providing records of invertebrates made in various locations during the field trip.

Table 1. List of invertebrates recorded in the study areas during the October 2020 field exhibition

No. of monitoring location	Coordinates	Date	Weather conditions	Recorded species
VP01.	41º 35'21.62" N 64º19'15.02" E	11.00 20.10.2020	Sunny.. +23º	*Anacanthotermes turkestanicus, Acarididae, Tenebrionidae*
VP02.	41º 34'49.94" N 64º21'17.33" E	12.00 20.10.2020	Sunny.. +25º	*Hemilepistus* – Numerous burrows
VP03.	41º 35'47.05" N 64º22'56.31" E	12.43 20.10.2020	Sunny.. +25º	
VP04	41º 35'35.64" N 64º23'46.74" E	14.08 20.10.2020	Sunny.. +25º	
VP05.	41º 34'30.31" N 64º25'00.18" E	15.20 20.10.2020	Sunny.. +25º	
VP06.	41º 33'24.81" N 64º25'32.98" E	15.51 20.10.2020	Sunny.. +26º	
VP07.	41°33'6.19" N	17.20 20.10.2020	Sunny.. +19º	

No. of monitoring location	Coordinates	Date	Weather conditions	Recorded species
	64°26'14.36 "E			
VP08.	41°34'40.16 "N 64°26'43.44 "E	16.50 19.10.2020	Sunny.. +19º	
VP09	41º 36’51.18” N 64º28’40.63” E	15.50 19.10.2020	Sunny. Windy. +19º	*Anacanthotermes turkestanicus, Blaps sp., Asilidae*
VP10.	41º 33’11.67” N 64º28’09.06” E	16.29 20.10.2020	Sunny.. +20	
VP11	41º 35’29.97” N 64º28’45.86” E	10.00 19.10.2020	Sunny. Strong wind. +17º	
VP12	41º 34’49.29” N 64º30’10.1” E	10.51 19.10.2020	Sunny. Strong wind. +17º	
VP13	41º 34’32.4” N 64º32’03.62” E	12.29 19.10.2020	Sunny. Windy. +19º	
VP14.	41º 33’56.36” N 64º34’43.25” E	13.20 19.10.2020	Sunny. Windy. +20º	

Juru Energy

Entomological survey

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Contents

Introduction 3
Methods and collection of material 6
Survey methods 7
Physiographical characteristics of the survey areas 7
Vegetation 7
Conclusions and recommendations about research into terrestrial invertebrates 11
Bibliography 15

Introduction

Studies of the regional entomofauna were launched in the second half of the 19th century by researchers and travellers A. P. Fedchenko and O. A. Fedchenko, who made large collections of plants and insects in the Kyzylkum desert. Descriptions of a number of new species and information on the distribution of representatives of the Kyzylkum entomofauna can be found in A. P. Fedchenko's Trip to Turkestan series (1871—1873).

The most comprehensive work covering the insect fauna of the region is Entomofauna of South-Western Kyzylkum (A. G. Davletshina et al. 1979). In 1962—1964 the authors made research into the part of the desert between the Shafirkan village and Jingildy in the west, the Mingbulak depression in the north and Tamdybulak in the east. The route ran along the sky islands of Kuljuktau, Auminzatau, the southern portion of Bukantau, Tamdytau, and the Mingbulak, Karakata and Ayakagitma depressions.

In 1974—1975, in the north and north-east of the western portion of the Kyzylkum desert the survey covered the villages of Ayakagytma and Jingildy, Karakata depression, the towns of Zeravshan and Tamdybulak, in the south – Alat District of Bukhara Province and the Karakul Reserve, which is the southernmost point of the South-Western Kyzylkum.

According to the authors, this territory was inhabited by 1,100 species from 16 genera and 108 families, 3 of which are included in the Red Data Book of Uzbekistan: *Hypermnestra helios* Nickerl, 1846 (NT), *Satanas gigas* Eversmann,1855 (VU: R), *Reduvius fedtschenkianus* Oshanin, 1871 (VU: R).

The collection of papers Insects as Components of the Saxaul Forest Biocoenosis (Mamayev et al., 1975) on insects' species composition, ecology and their biocoenotic relations with plants was a great contribution to the study of the entomofauna of desert forest biocoenoses. The work reveals insects' evolution and distribution patterns in man-planted saxaul woods.

G. M. Dlussky made big research into the ants of the desert in 1960—1970, which resulted in the monograph Ants of the Desert (Dlussky 1981).

The entomofauna of specific desert plants was studied in subsequent years – saxaul (Nurmuratov, 1971), Calligonum (Yelyubayev, 1974), sagebrush (Moiseyeva, 1965, Korniyenko, 1967), sand acacia (Soitova, 1974) and other.

In April 2014, May 2015 and September 2017, 3 joint Russian-Uzbek expeditions were organised as part of an international cooperation agreement between the Karshi and

Nizhny Novgorod State Universities to inventory the entomofauna of certain regions of Uzbekistan. The results of the first expedition, including the itinerary with the coordinates of locations where the material was collected, were published in a special issue of the 'Эверсмания' (Eversmannia) magazine (Anufriyev, Rahimov, 2015 and other). The same issue contains an article describing 24 ant species (Mokrousov, Zryanin, 2015).

In 2017, A. G. Blummer described a new species in the Kyzylkum desert – *Uranembia rivkusi* Blyummer.

The following researchers studied the entomofauna of Uzbekistan: general studies – A. G. Davletshina, A. A. Bekuzin, D. A. Azimov (1993); F. N. Pravdin (1978); orthopterans – M. Zh. Medetov (2018); hemipterans – A. N. Kirichenko (1951), V. F. Oshanin (1912); termites – A. Sh. Khamrayev, N. I. Lebedeva, K. Zh. Rustamov, T. I. Zhuginisov, G. S. Mirzayeva (2016), coleopterans – Protsenko (1968), Lopatin (1961), G. V. Nikolayev (1987, 2002); cockroaches – G. Ya. Bey-Biyenko (1950), mantis – I. I. Lindt (1953, 1955, 1961, 1963, 1968, 1977), F. N. Pravdin (1978); stick insects – L. L. Mishchenko (1945), earwigs – G. Ya. Bey-Biyenko (1936).

However, in general, desert entomocoenoses are not studied properly. There are no comprehensive, generalising works on or full lists of Central Asian desert insects.

According to the latest 2019 edition of the Red Data Book of Uzbekistan, the portion of Kyzylkum adjacent to the construction site is inhabited by 8 insect and 1 arachnid species from the Red Data Book:

Class – Arachnida

Order – Aranei

Family – Theridiidae

Gender – Latrodectus Walckenaer, 1805

1. *Lathrodectus dahli* Levi, 1959 (NT)

Class – Insecta

Order – Diptera

Family – Syrphidae

2. *Lathyrophthalmus quinquelineatus* Fabricius, 1781 (VU:R)
3. *Eumerus ferulae* Stackelberg, 1965 (EN)

Order – Hymenoptera

Family – Crabronidae

4. *Kohlia pavlowskii* (Gussakovskij, 1952) (VU:R)
5. *Larra transcaspica* F. Morawitz, 1894 (VU:R)

Family – Sphecidae

6. *Prionyx nigropectinatus* (Taschenberg, 1869) (VU:R)
7. *Prionyx macula* (Fabricius, 1804) ssp. lugens Kohl, 1890 (VU:R)
8. *Fedtschenkia indigotea* Radoszkowski, 1886 (EN)

Order – Lepidoptera

Family – Noctuidae

9. *Catocala remissa* Staudinger, 1891(VU:D)

A. G. Ahmedov (2020) identified 50 ant species in this area, 1 of which, *Tetramorium nitidissimum* Pisarski, 1967, was proposed for the inclusion in the next Red Data Book edition.

Apart from those from the Red Data Book, other important species inhabiting the territory include *Anacanthotermes turkestanicus* Jacobson, 1904, which can significantly damage the wooden parts of various man-made structures. Moreover, they can live inside reinforced concrete structures and cause their subsidence.

Another interesting group of insects in the territory is fleas transmitting various infectious diseases. According to I. G. Ioff (1965), the place is a habitat for about 12 flea species, including fleas of gerbils – *Xenopsylla gerbilli* (Wagner, 1903), *Xenopsylla conformis* (Wagner, 1903), *Xenopsylla hirtipes* Rothschild, 1913, *Stenoponia vlasovi* Ioff et Tiflov, 1934, fleas of the yellow ground squirrel –*Citellophilus tesquorum* (Wagner, 1898), *Citellophilus trispinus* (Wagner et Ioff , 1926), *Neopsylla setosa* (Wagner, 1898), which are main carriers of dangerous infectious diseases and, taking into account the area is inhabited by relatively large numbers of the yellow ground squirrel, Lybian and midday jirds and great gerbil, carriers of particularly dangerous infections, are highly important for the science.

Methods and collection of material

Since often it is impossible to identify reliably the species of an insect without examining it with a microscope or magnifying glass, the insects were caught with the help of special traps and later identified in a laboratory or right in the field. We did our best to collect minimum required quantities of material to avoid damaging the environment. The entomologic material was collected with the use of the following pitfall and other traps.

Barber pitfall traps are glasses or small glass jars buried vertically in the ground, with the rim level with the ground surface. The inner sides of the vessel are clean and smooth, so that trapped insects could not get out. The bottom was laid with dry leaves, with cat food as bait. Wherever possible, the traps were installed in a straight line at camps for 24 hours. Information about every trapped animal was immediately entered into a journal under its official name, if it was identified by the head of the expedition, or under a provisional name. The information included a detailed description of the place and area the sample was taken from.

Light traps consisted of LED torches with a piece of white cloth stretched in front. The light traps were installed at camps for a night. Insects attracted by the torch were collected manually, with the help of pincers.

Butterfly or flying insect nets. To catch insects, light telescopic butterfly nets were used during transects or at camps.

Moericke traps are yellow plastic bowls with water with some shampoo added. These traps were installed early in the morning.

A **malaise trap** consists of three walls fastened together to form the letter H and a roof-like top. A trapping glass is fixed outside to the upper corner of the taller front wall. The walls are black inside and white outside. The following principle is used in the malaise trap: flying insects meet the central black wall and fly upwards to gather in the upper corner of the trap with a round aperture, through which the insects then get into the trapping vessel. The vessel is fixed with the help of two rings. Malaise traps were installed in the morning and middle of the day and alternated with Moericke traps.

After the expedition, the material that could not be identified in the field was carefully sorted for subsequent storage and identification. The samples were treated at the entomology laboratory at the Institute of Zoology, Academy of Sciences of Uzbekistan, with the help of a binocular digital microscope, pincers, microscopic needles and petri dishes. The samples were put into the petri dishes and examined with the help of the binocular microscope.

Survey methods

Transect and area surveys were used in the studies. Transects were employed for noticeable and easily identifiable large-size species, such as mantis, various beetles, butterflies and dragonflies, as well as their nests (wasps, ants). Transects were 1 km long and 2 m wide. One of the varieties of transect – current recording method – was used in complex topographies. In this case, the 1-kilometre-long line was divided into two 500-metre or five 200-metre sections, depending on the terrain. As they moved along a transect, researchers recorded in their notebooks every insect that could be identified right on the spot. In addition, insects along the transects were caught using a net. All transects were recorded with the help of GPSs.

Physiographical characteristics of the survey areas

The studied areas are located in the Kyzylkum desert. The desert is a unique physiographical region spreading over the interfluvial area between the Amudarya and Syrdarya in Uzbekistan. In the north-west it is bordered by the Aralkum desert and Aral Sea, in the north-east by the Syrdarya river, in the east by the spurs of the Tien Shan and Pamir-Alai and in the south-west by the Amudarya.

The study area encompassed low sky islands and piedmont plains occupied by gypsum deserts.

Accumulative temperatures in the growing season are quite high in the area, while relative humidity in the daytime in July is never above 20%, usually ranging within 15-16%. About 45% of annual precipitation falls in spring.

Because of low precipitation, very dry air and high temperatures in summer, the soil dries up somewhat earlier than in more humid regions of Uzbekistan. Nevertheless, due to a lower wilting point, the drought on sandy and sandy-loamy soils affects vegetation less than in loamy and clayey areas.

Vegetation

The vegetation in the studied area is highly diverse. One of the typical plants is the semi-shrub sagebrush *Artemisia*. Sagebrush associations occupy large areas of the gypsum desert on the piedmont plains of Tamdytau.

Intense overgrazing in the desert leads to strong changes in the numbers and composition of natural biocoenoses. *Peganum harmala* develops actively on heavily overgrazed areas.

Between 9 and 22 April 2021, A. G. Akhmedov, a researcher from the entomology laboratory at the Institute of Zoology, Academy of Sciences of the Republic of Uzbekistan, carried our research into the arthropod fauna on the construction site of the proposed wind farm and power lines in the Tamdytau area. All recorded insect species have the status of 'not listed.'

Studied, total:

No. of monitoring location	Coordinates	Material collection date	Biotope	Recorded species, including from the Red Data Book
Location 1	41º 35'21.62" N 64º19'15.02 "E	15 April 2021	Piedmont plains and low foothills	Lycosa sp. Hemilepistus sp. Tetramorium schneideri Plagiolepis pallescens Cataglyphis setipes Cerceris sp. Polistes watii
Location 2	41º 34'50.14" N 64º21'10.52 "E	17 April 2021	Foothills	Hemilepistus sp. Lycosa sp. Camponotus interjectus Pieris rapae
Location 3	41º 35'47.05" N 64º22'56.31 "E	15 April 2021	Piedmont plains and low foothills	Lycosa sp. Camponotus interjectus Pontia sp. Vespa orientalis Reduvius sp. Chrysoperla carnea
Location 4	41º 35'35.64" N 64º23'46.74 "E	15 April 2021	Piedmont plains and low foothills	Lycosa sp Pimelia sp. Microdera sp. Messor laboriosus Lepisiota semenovi Cardiocondyla uljanini
Location 5	41º 34'30.31" N 64º25'00.18 "E	15 April 2021	Low clayey mountains	Lycosa sp. Microdera sp. Messor laboriosus Lepisma sp. Embia tartara Vespa orientalis Scarabeus sacer Anacanthotermes turkestanicus

No. of monitoring location	Coordinates	Material collection date	Biotope	Recorded species, including from the Red Data Book
Location 6	41º 33’24.81” N 64º25’32.98 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Anacanthotermes turkestanicus Polistes watii Ammophila sp. Messor laboriosus Lepisiota semenovi
Location 7	41°33'6.19" N 64°26'14.36 "E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Anacanthotermes turkestanicus Cataglyphis aenescens Messor laboriosus Pimelia sp.
Location 8	41°35'10.88 " N 64°26'18.44 "E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Anacanthotermes turkestanicus-термит Pimelia sp. Scolopendra
Location 9	41º 36’51.18” N 64º28’40.63 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Cicindela sp. Mesobuthus sp. Chrysoperla carnea Halictus sp. Eucera Anacanthotermes turkestanicus
Location 10	41º 33’11.67” N 64º28’09.06 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Lepisma sp. Embia tartara Messor laboriosus Tetramorium shneideri
Location 11	41º 35’29.97” N 64º28’45.86 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Lepisma sp. Pimelia sp. Messor aralocaspius Lepisiota semenovi Scolopendra.

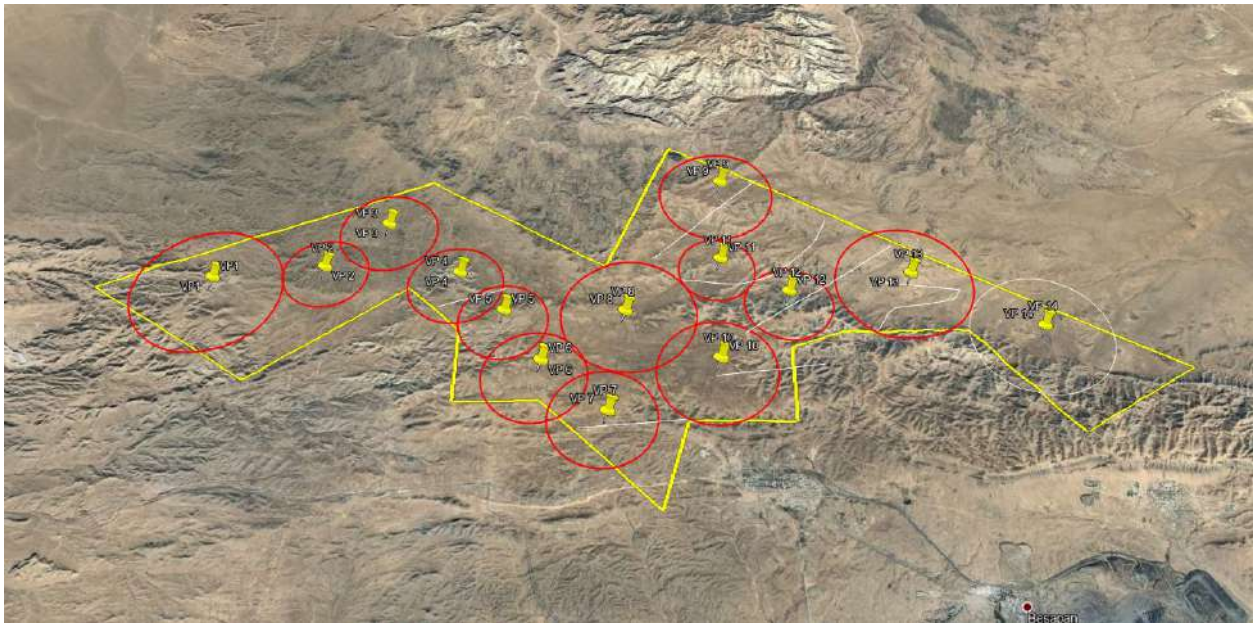
No. of monitoring location	Coordinates	Material collection date	Biotope	Recorded species, including from the Red Data Book
Location 12	41º 34’49.29” N 64º30’10.1” E	17 April 2021	Piedmont plains and low foothills	Lycosa sp. Anacanthotermes turkestanicus Tetramorium schneideri Plagiolepis pallescens
Location 13	41º 34’32.4” N 64º32’03.62 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Anacanthotermes turkestanicus Cerceris sp.
Location 14	41º 33’56.36” N 64º34’43.25 ”E	16 April 2021	Piedmont plains and low foothills	Lycosa sp. Lepisma sp. Anacanthotermes turkestanicus Tetramorium schneideri Cardiocondyla uljanini Tapinoma erraticum

Conclusions and recommendations

The invertebrate fauna in the studied area is relatively poor. The most abundant are tarantulas, which occur in large numbers all across the studied area, woodlice from the genera Hemilepistus, darkling beetles (Pimelia sp., Microdera sp.), various ants (Messor, Cataglyphis, Tetramorium, Lepisiota) and the termite *Anacanthotermes turkestanicus*, *Embia tartara* and Lepisma sp. are often found under stones in cool places. Various bees (Halictus, Eucera) were recorded on small flowers growing in small numbers in depressions and on mountain slopes. Other insects were rare. No rare, endemic or Red Data Book species were observed. It should be noted that we also surveyed this territory between 2014 and 2016, but did not record any rare or Red Data Book species, either.

In general, we do not observe any potential threat for the entomofauna on the construction site, but we recommend that the construction work have as little impact on the site as possible.

Attachments



Studied locations on the Zarafshan WF project territory (Tamdytau)

Scolopendra

Camponotus interjectus

A tarantula's nest with the shells of woodlice, the spider's prey, around it

Lepisiota semenovi

Pontia

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Mammals report

ZARAFSHAN WIND FARM PROJECT:

CLIENT: WOOD GROUP

Date: December 2020

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REPORT

on Results of field survey on mammals inhabited on the Zarafshan WF project area
(Tamdy province, Navoi region of Uzbekistan)

by Alexander Esipov and Elena Bykova assisted by Ramz Sakhubnazarov

1. Introduction

Data survey: November 21-24, 2020.

Aim: To study mammal species status and distribution in project and surrounding areas

Goals:

1. To conduct ground survey on mammal species (different from bats) in project area;
2. To collect data from settled camera traps and resetting camera traps in most suitable locations to get information about mammal species presence, distribution, seasonal dynamic and behavior;
3. To collect questionnaire data from local people on mammal species presence/absence, status and threats;
4. To analyze preliminary field data including species number and distribution;
5. To develop mammal species list based on field data, questionnaire data and data from literature sources, including endangered and non-endangered species.

The survey was done by Alexander Esipov and Elena Bykova.

2. Material and methods

During the field survey a nine monitoring sites (stationers) have been studied (Fig. 1; table 1). We tried to study as project site as well surrounded areas within the 5 km zone in terms to cover different landscapes including degraded mountains (Big and Little Aktau, Tamdytau ridge), mountain foothills, vegetation semi-desert with *Artemisia* and *Salsola* plant associations, mountain steppe with rocks, elements of sandy desert and tugai (river) forest. In each of nine monitoring site we settled/re-setted camera traps (8 camera traps – green points in fig 1), three cameras have been take off from previous locations (yellow points in fig 1) and re-located in different places to get more material.

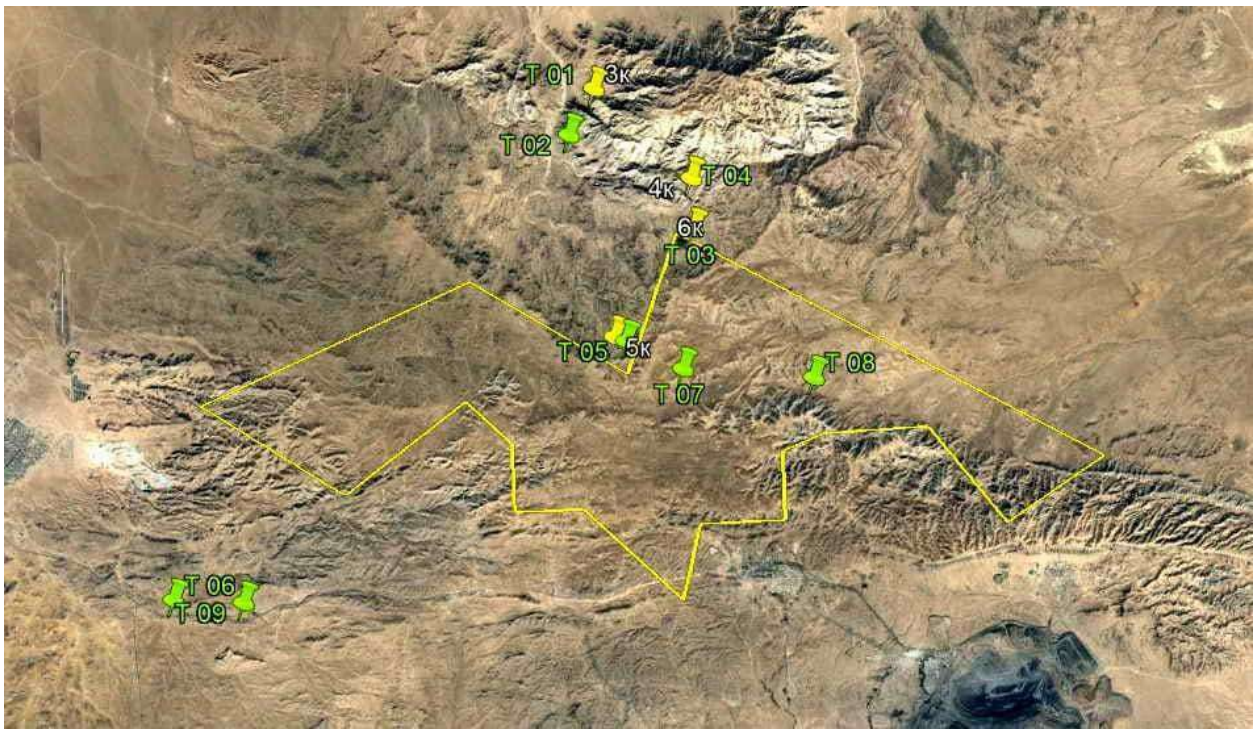

Fig. 1 Map of the Monitoring sites (green points – resent past camera traps locations, yellow points – past camera traps)

During ground survey we studied about mammal species number and species composition in walking survey transect. The length of each walking transect was 2 km in each monitoring point, with total length of 18 km (table 1).

During the field research, non-invasive technologies were used, not related to the capture and killing of wild animals, including:

- visual observation of mammals both by eye and using 10x binoculars;
- registration of tracks of the vital activity of wild mammals, including animal tracks (paw foot prints on the ground), feces, digging, burrows, dead animals, etc.
- taking photo of the animals, their tracks and traces of their vital activity, typical habitats.

The studied area was recalculated by multiplying the length of the traversed route by the width of the surveyed transect, which is determined taking into account visibility, relief, vegetation, and particular species. For instance, animal footprints on the ground, their feces, burrows of small mammals (e.g. Small five-toed jerboa *Allactaga elater*) are visible at a distance of up to 2 m, burrows of yellow ground squirrel *Spermophilus fulvus* and midday jird *Meriones meridianus* are visible at a distance up to 5 m, colonies of Libyan jird *Meriones libycus* - up to 10 m, a colonies of great gerbil *Phombomys opimus* and a mole vole *Ellobius tancrei* - up to 20 m. Then as medium-sized animals (e.g. red foxes *Vulpes vulpes*) are visible at a distance of up to 150 m. Ungulate species like Goitered gazelle *Gazella subgutturosa* and Severtsov's argali *Ovis ammon severtzovi* can be found up to 500 m.

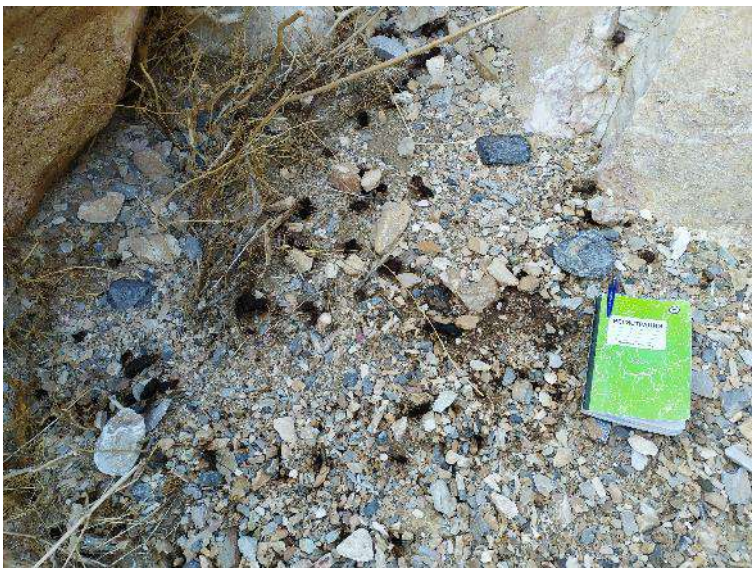

Fig. 2 Scats of Marbled Polecat

Fig. 3 Scats of Red Fox

Results and discussion

Totally during field survey in November 21-24, 2020 we recorded 13 mammal species including 8 rodents, 1 hare, 1 bat, 3 carnivores (tables 1, 2). Also we recorded 3 Goitered gazelles during the movement from T02 to T03 monitoring sites. Presence of such species as Marbled Polecat, Botta's serotine, Carruther's vole requires additional confirmation with using different methods (trapping, camera trapping, sound detection).

Table 1 Mammals recorded in monitoring sites during field survey in the project area (Tamdyn province, Navoi region, Uzbekistan) in November 21-24, 2020

№ Monitoring site	Coordinates, WGS-84, grade/min/sec	Altitude, m asl	Biotope	Mammals recorded in monitoring site
T01	41°39'48.6" 64°25'54.7"	408	Dry stream on big Aktau. Marble exits	*Vormela peregusna* (?)
T02	41°39'03.6' 64°25'19.5"	423	Dry stream with low niches.	*Vormela peregusna* (?) *Phombomys opimus*

T03	41º37'24.3' 64º28'02.1"	630	'Black Mountain' - Niche under the rock, rock scree	*Ellobius tancrei* *Lepus totai* *Vulpes vulpes*
T04	41º38'16.3" 64º28'00.6"	633	Rock with a golden eagle's nest	*Vormela peregusna* (?) *Meriones libycus* *Vulpes vulpes*
T05	41º35'34.4" 64º26'26.5"	753	Rock jag on the mountain.	Botta's serotine (?) *Vulpes vulpes*
T06	41º31'30.1" 64º16'07.4"	493	Dry bed under the railway. Sandy-clayey soil	*Spermophilopsis leptodactylus* *Meriones meridianus* *Vulpes vulpes*
T07	41º35'04.8" 64º27'41.5"	743	Hilly area. Rocky 'tooth' on top	*Ellobius tancrei* *Spermophilus fulvus Allactaga elater* *Meriones libycus* *Vulpes vulpes*
T08	41º34'51.3" 64º30'36.8"	620	Mountain steppe with rocky outcrops	*Ellobius tancrei* *Spermophilus fulvus* *Microtus carruthersi* (?) *Vulpes vulpes*
T09	41º31'25.1" 64º17'41.2"	505	Tugai along the stream with flowing water	*Meriones libycus* *Mustela nivalis* *Vulpes vulpes*

More detailed information about mammal's number (density) and species composition we recorded in walking 2 km transects presented in table 2. Also we added information about other species (birds, reptiles) we have recorded during field survey in transects.

Fig. 4 Residential colony of Libyan jird

Fig. 5 Residential colony of Goitered gazelle footprint

Table 2 Species composition and number in walking transects, November 21-24, 2020

№	Species	Monitoring site	route length (km) / surveyed area (ha)	Number, individuals/colonies/ burrows	Number assessment
Mammals					
1	Botta's serotine (?) (feces)	T05	-	1 colony	A few
2	*Lepus totai* (feces)	T03	18 / 7,2	2 indi	A few
3	*Spermophilopsis leptodactylus* (footprints)	T06	18 / 7,2	1 indi	A few
4	*Spermophilus fulvus* (burrows)	T07, T08	18 / 18	4+3=7 burrows	Not numerous
5	*Allactaga elater* (burrows)	T07	18 / 7,2	5 burrows	A few
6	*Ellobius tancrei* (residential colony)	T03, T07, T08	18 / 72	3+2+5 =10 colonies/18 km	Common
7	*Microtus carruthersi* (?) (residential colony)	T08	18 / 18	1 colony	A few
8	*Meriones libycus* (residential colony)	T04, T07, T09	18 / 36	1+3+2 =6 colonies/18 km	Common
9	*Meriones meridianus* (residential colony)	T06	18 / 18	2 colonies	A few
10	*Phombomys opimus* (residential colony)	T02	18 / 72	1 colony	A few
11	*Vulpes vulpes* (footprints, digging, feces)	T03, T04, T05, T06, T07, T08, T09	18 / 7.2	1+2+1+ 1+8+2+ 3=18 indi/18 km	Numerous
12	*Vormela peregusna* (?) (feces)	T01, T02, T04	18 / 7,2	5 indi/18 km	common
13	*Mustela nivalis* (footprints)	T09	18 / 7.2	2 indi	A few
Other species					
Birds					
	Neophron percnopterus (visually)	T01		2	
	Gyps fulvus (visually)	T01		1	
	Falco cherrug (visually)	T01, T02		2	
	Falco tinnunculus (visually)	T01		1	
	Falco tinnunculus (pellets)	T03		10	
	Alectoris chukar (visually)	T08		11	
	Alectoris chukar (toilets in sleeping places)	T01, T03, T04, T05, T08		12+3+12+ 10+13=50	
	Aquila chrysaetos (nests)	T04, T07		2+1	
Reptiles					
	Testudo horsfieldii	T04, T07		about 50 shells under the nest of the golden eagle(T04) and 10 shells in resting place of golden eagle in T07	

The result of a survey shown that from one to five species of mammals were observed at the one monitoring sites, on average 2.8 species of mammals per route.

Seven species of mammals were recorded only at one of the surveyed sites. These are bats, tolai hare, long-clawed ground squirrel, small five-toed jerboa, Cerruther's vole, midday jird and great gerbils. Representatives of other species were found on two, three sites, and the most common for this region species - red fox recorded even on seven of 9 sites.

Libyan jird is dominant species in rodent's community. It has a higher abundance (1.7 inhabited colonies/10 ha) among recorded 8 rodents. Almost the same number demonstrate sub-dominant species - mole vole.

Fig. 6 Footprints of weasel (small one at the left side) and red fox (big one at the right side)

Also we analyzed materials from four Bushnell camera traps installed on October to make adds to general species list. The results of this analysis in Table 3.

Table 3 Materials captured by Bushnell camera traps during the period from October 21 to November 21, 2020

camera number	coordinates	Installation data	dismantling date	number of shots	number of productive shots	species	Data of record/notes
3	41°39'07' 64°26'09"	21.10. 2020	21.11. 2020	72	26	Desert lark *Ammomanes deserti*	Oct 27, Nov 9, 11, Nov 13 (max 16 rec per day)
4	41°39'3" 64°26'13"	21.10. 2020	21.11. 2020	46	22	Desert lark *Ammomanes deserti*	Oct 27 (max 4 rec per day), Oct 28, 29, 30, 31, Nov 1, 4 5, 6
						Hemorrhois ravergieri *Hemorrhois ravergieri*	Nov 3
						Grey dwarf hamster *Cricetulus migratorius*	Nov 6-7

						Chukar Alectoris chukar	Oct 31 (3 individuals)
5	41°38'58” 64°25'43"	21.10. 2020	21.11. 2020	27	0	-	-
6	41°39'03.6' 64°25'19.5"	21.10. 2020	21.11. 2020	43	23	Chukar Alectoris chukar	Nov 25 (3 rec up to 6 birds per shot), Nov 26, 29
						Wild cat *Felis sylvestris ornate*	Oct 30 окт (10 records), Nov 3 (2 records), Nov 12)
						Red fox	Nov 21 ноя (4 records)

Fig. 7 wild cat from Bushnell camera

Fig. 8 red fox from Bushnell camera

Fig. 9 Grey dwarf hamster from Bushnell camera

Thus, during the field trip, 16 species of mammals from 5 orders were recorded. To get additional long term data on mammals, it's distribution and threats we organized meeting with zoologists from Antiplague service in Zerafsjan city (APS-Zerafshan). This is zoologists who involved in work on pest control in Central Kysylkum over long time period. In addition, we used our own data collected in this region at past as well as some literature data. All of this allowed us to prepare prelaminar species list of mammals including endangered species, inhabited in project area (table 4). This list includes species name (scientific and common), population estimate, category of threat under IUCN Red List and Red Data Book of Uzbekistan (2019).

Table 4 Characteristics of mammals in the project area and adjacent areas of Tamdytau and Central Kyzylkum

№	Species	Conditional population estimate	Status of threat IUCN RedList/Uzbekistan RDB	Sources
1	Long-eared hedgehog *Hemiechinus auritus* Gmelin, 1770	O-M	LC/-	Our data
2	Brandt's hedgehog *Paraechinus hypomelas* (Brandt, 1836)	P-E	LC/3NT	Kashkarov, 2019
3	Lesser white-toothed shrew *Crocidura suaveolens* Pallas, 1811	O-H	LC/-	Our data
4	Piebald shrew *Diplomesodon pulchellum* (Lichtenstein, 1823)	P-E	LC/-	Data by APS-Zerafshan
5	Tolai hare *Lepus totai* Pallas, 1778	O-M	-	Our data
6	Lesser mouse-eared bat *Myotis blythii* (Tomes, 1857)	O-H	LC/-	Bogdanov, 1953, 1991; Gritsina et al, 2013a, 2013б
7	Botta's serotine *Eptesicus bottae* (Peters, 1869)	O-H	LC/-	Bogdanov, 1953, 1991; Gritsina et al, 2013a, 2013б

8	Long-clawed ground squirrel *Spermophilopsis leptodactylus* (Lichtenstein, 1823)	O-H	LC/-	Our data
9	Yellow ground squirrel *Spermophilus fulvus* (Lichtenstein, 1823)	O-M	LC/-	Our data
10	Small five-toed jerboa *Allactaga elater* (Lichtenstein, 1825)	O-M	-	Our data; Data by APS-Zerafshan
11	Severtzov's jerboa *Allactaga severtzovi* Vinogradov, 1925	O-H	LC/-	Data by APS-Zerafshan
12	Northern three-toed jerboa *Dipus sagitta* (Pallas, 1773)	O-H	LC/-	Data by APS-Zerafshan
13	Great gerbil *Phombomys opimus* (Lichtenstein)	O-M	LC/-	Our data; Data by APS-Zerafshan
14	Libyan jird *Meriones libycus* Lichtenstein, 1823	O-M	LC/-	Our data
15	Midday jird *Meriones meridianus* (Pallas, 1773)	O-M	LC/-	Our data
16	Grey dwarf hamster *Cricetulus migratorius* Pallas, 1773	O-H	LC/-	Our data
17	Zaisan Mole Vole *Ellobius tancrei* Blasius, 1884	O-M	LC/-	Our data
	Carruther's vole *Microtus (Neodon) carruthersi* Thomas, 1909	O-H	-/-	Our data
18	*Mus musculus* Linnaeus, 1758	O-H	-/-	Our data
19	Grey wolf *Canis lupus* (Linnaeus, 1758)	P-E	LC/-	Data by APS-Zerafshan
20	Corsac Fox *Vulpes corsac* (Linnaeus, 1768)	P-E	LC/2(VU:D)	Mitropolskaya, 2019
21	Red fox *Vulpes vulpes* Linnaeus, 1758	O-M	LC/-	Our data
22	Weasel *Mustela nivalis* Linnaeus, 1766	O-H	LC/-	Our data; Data by APS-Zerafshan
23	Marbled Polecat *Vormela peregusna* (Güldenstädt, 1770)	P-E	VU/2(VU:D)	Data by APS-Zerafshan
24	Steppe Polecat *Mustela eversmanii* Lesson, 1827	P-E	LC/2(VU:D)	Mitropolskaya, Kashkarov, 2019
25	Asian Badger *Meles leucurus* (Hodgson, 1847)	P-E	LC/-	Our data
26	Asiatic wildcat *Felis sylvestris ornate* Gray, 1830	O-H	-	Our data
27	Sand cat *Felis margarita* Loche, 1858	P-E	LC/3NT	Data by APS-Zerafshan; Gritsina, 2019
28	Caracal *Caracal caracal* (Schreber, 1776)	P-E	LC/1(CR)	A.S. Nuridjanov pers. comm. June 2005; Gritsina et al., 2016; Gritsina, 2019
29	Wild boar *Sus scrofa* Linnaeus, 1758	O-H	LC/-	Data by APS-Zerafshan
30	*Ovis ammon* (Linnaeus, 1758) ssp. *severtzovi* Nasonov, 1914	P-H	NT/2(VU:D)	Beshko, 2019

31	Goitered Gazelle *Gazella subgutturosa* (Güldenstädt, 1780)	P-H	VU/3(VU)	Our data; Data by APS-Zerafshan; Marmazinskaya, Gritsina, 2017; Marmazinskaya, 2019

Notes: *Conditional estimate of the number: E - single, H - few, M - Numerous; O - common, R - rare. IUCN Red List categories: Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threat (NT); Least concern (LC); Data Deficient (DD); Categories of the Red Data Book of the Republic of Uzbekistan (2019): Extinct 0 (EX); Extinct in the Wild 0 (EW); Critically Endangered 1 (CR); Endangered 1 (EN); Vulnerable 2 (VU: D); Naturally Rare 2 (VU: R); Near Threat 3 (NT); Data Deficient (DD).*

Thus, based on the results of the November survey, our previous data, as well as taking into account the data obtained through the questionnaire survey and from the literature, we have compiled a list of mammals for the project area and the nearby territories of Tamdytau and Central Kyzylkum. In total, the list included 31 mammals, including 8 Endangered species listed in Uzbek Red Data Book (2019) and IUCN Red List (table 4). This list is preliminary. We will extend and correct it in future using data camera traps, sound detectors, as well as spring ground survey data we planned for 2021.

3. Appendix

Table 5 Places of camera traps installation

№ monitoring site	Photo
T 01	
T 02	
T 03	

T 04	
T 05	
T 06	
T 07	
T 08	
T 09	

Fig. 10 Wild cat in Aktau ridge, 30.10.2020. Record from camera trap

Fig. 11 Small herd of Goitered gazelles in foothills of Big Aktau ridge

Juru Energy

MAMMAL

SURVEY

ZARAFSHAN WIND FARM PROJECT:

CLIENT: WOOD GROUP

Date: June 2021

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Contents

MATERIAL AND METHODS 3
RESULTS AND DISCUSSION 5
Ground transect survey 5
Camera trapping 8
Results investigation of the road effect on animals 14
CONCLUSIONS 19
REFERENCES 20
Appendix 1. CAMERA TRAPS RECORDS OF MAMMALS AND SOME OTHER SPECIES 21

INTRODUCTION

The field survey was conducted on April 11-15, 2021.

Aim: To study mammal species status and distribution on project site and surrounding areas

Goals:

1. To conduct addition ground survey on mammal species (excluding bats) in project area during spring time;
2. To collect data from settled camera traps (from November 2020 till April 2021) and resetting camera traps in most suitable locations to get more information about mammal species presence, distribution, seasonal dynamic and behavior;
3. To analyse preliminary field data including species number and distribution;
4. To develop mammal species list based on field data, questionnaire data and data from literature sources, including endangered and non-endangered species.

MATERIALS AND METHODS

The research was carried out in the Central Kyzylkum desert, in area of degraded mountains: Aktau, Muruntau ridges, incl. vicinity of Zarafshan city as well as along the main road A379, Navoi-Zarafshan site (fig. 1).

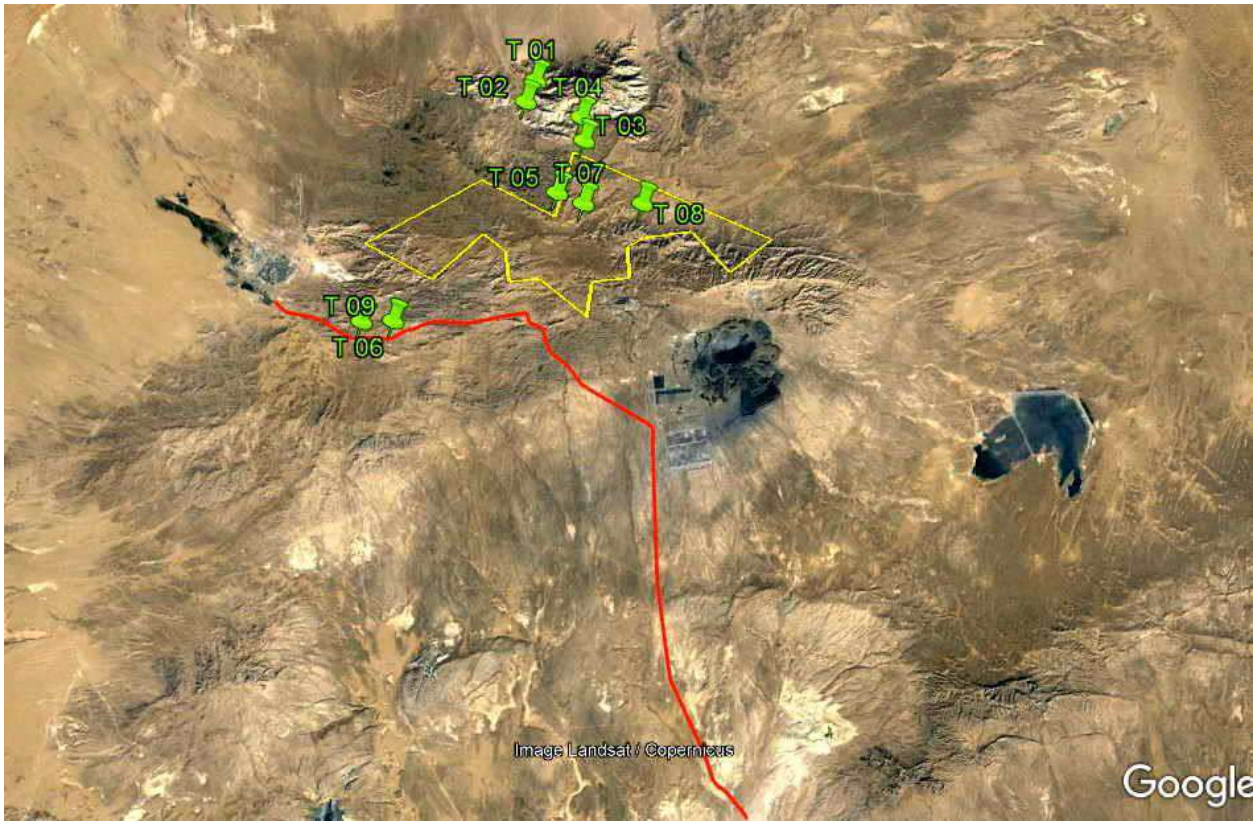

Figure 1 Map of the Monitoring sites (green points – resent camera traps locations, red line – road A379, Navoi-Zarafshan site)

During our survey we used three basic methods:

1. Ground vehicle and walking transect survey;
2. Camera trapping; and
3. Assessment accidentally killed animals by vehicles on the road.

During ground transect survey we studied about mammal species number and species composition in vehicle (80 km) and walking transect survey. The length of each walking transect was 1 km in each monitoring point, with total length of 8 km (table 1).
During the field research, non-invasive technologies were used, not related to the capture and killing of wild animals, including:

- visual observation of mammals both by eye and using 10x binoculars;
- registration of tracks of the vital activity of wild mammals, including animal tracks (paw foot prints on the ground), feces, digging, burrows, dead animals, etc.;
- registration of animals accidentally killed on the road Navoi-Zarafshan by vehicle;
- taking photos of the animals, their tracks and traces of their vital activity, typical habitats.

Camera traps (Bushnell Trophy Cam) were installed in November 2020 - April 2021. In April we collected most of camera traps, 3 of them have been re-installed to get addition data. In total cameras were installed for six months at 8 stations in various types of biotopes (dry mountain streams, mountain steppe with rocks and caves, sandy desert and tugai (river) forest) in the places of the most probable presence of animals (trails, watering points, animal marking places, and places of natural constrictions of relief). One of 8 camera traps has been stolen by local people, one more didn't work for technical reasons. So, in this report we are analyzing actual data from 6 cameras (tables 2, 3). As was notes in previous report (see report from November 2020) we tried to study as project site as well surrounded areas within the 5 km zone in terms to cover different landscapes including degraded mountains, mountain foothills, vegetation semi-desert with *Artemisia* and *Salsola* plant associations, mountain steppe with rocks, elements of sandy desert and tugai (river) forest. We also re-installed 3 camera traps in more productive stationaries to collect data over spring and early summer season. Totally we carried out camera trapping during 854 camera traps/days. In result 3349 total captures including 753 effective captures with animal records were collected.

We also carried out additional survey on species and number of animals dead due to traffic accidents (roadkill) on the road A379 Navoi-Zarafshan in site located close to the project area (table 3). Total length of transect is 150 km. The date of observation is April 12, 2021. Characteristics of road: the asphalt road, two-way traffic. The quality of the coverage is average. The average number of cars on the road if 5.5 cars per minute. Maximum speed is 100-120 km/h.

RESULTS AND DISCUSSION

Ground transect survey

This time we carried out addition ground transect survey to collect spring data with focus on seasonal species (ground squirrels) during camera trapping. Totally 5 mammal species have been registered visually and by the tracks of the vital activity (table 1), including *Spermophilus fulvus* that was recorded only by burrows during our autumn survey.

Table 1 Mammals species composition and number registered by vehicle and walking transects during field survey in the project area (Aktau, Muruntau degraded mountains and pre-Zeravshan desert, Tamdy province, Navoi region, Uzbekistan) in April, 13-14, 2021

№№	Species	Monitoring site	Number, individuals/colonies/ burrows	Survey methods	Number assessment
1	*Spermophilus fulvus*	Zeravshan_Uzkuduk road Muruntau ridge foothills T05, T07, T09	4 indi + 6 indi 10 inhabited holes + 2 inhabited holes	Vehicle survey (80 km) Ground transect survey (3 km)	Common, widely distributed
2	*Ellobius tancrei*	Muruntau ridge foothills T03, T07	11 inhabited colonies +1 inhabited colony and 2 winter passes + 6 inhabited colonies	Vehicle transect survey (70 km) Ground transect survey (2 km)	Common, widely distributed
3	*Phombomys opimus*	T06	3 colonies	Ground transect survey (1 km)	Common, widely distributed
4	*Meriones libycus*	T01	3 inhabited colonies	Ground transect survey (1 km)	Common, widely distributed
5	*Vulpes vulpes*	T01, T02, T05, T06, T07, T08, T09	2+ 1 tracks 5 +2 +1 + 2+3 scats 1 indi (visually)	Ground transect survey (7 km)	Common, widely distributed

***Spermophilus fulvus* on the monitoring site - T05**

Winter passes made by *Ellobius tancrei* on the monitoring site - T07

Camera trapping

In total, we recorded 31 species including 3 reptiles, 17 birds and 7 mammals. Mammals represented by one *Insectivore* species, four *Rodents* and two *Carnivores* (table 2). In addition we collected data on domestic livestock (sheep, horses) and domestic dogs that demonstrate existing level of livestock presence in the investigated area. Based on our records *Red fox, Libyan jird* and *Asiatic wildcat* are most wildly distributed species that inhabit most represented types of biotopes including mountain regions, foothills, river forest. Such species like *Lesser white-toothed shrew, Grey dwarf hamster, Small five-toed jerboa* and *Midday jird* were recorded relatively rarely. It is important to note those species were met during all observation time and didn't avoid anthropogenic landscapes – areas close to settlement (T09) and shepherd's stops in mountain regions, Aktau ridge (T01, T03, T08).

Reptiles including endangered *Central Asian tortoise* recorded in spring time (April) in foothills of Aktau and Muruntau, and in lowlands in tugai forest that reflected their biological feature. We also collected data on 17 bird species. *Chukar* is one of most numerical species that was recorded 72 times in groups of 2-11 birds (the average size of group is 3.3 birds).

Table 2 List of mammals and other species recorded by camera traps (Aktau, Muruntau degraded mountains and pre-Zarafshan desert, Tamdy province, Navoi region, Uzbekistan) in the period of November 22, 2020 to April, 14, 2021

№ п/п	Species	Number of records	Biotopes	Monitoring site
Mammals				
1	Lesser white-toothed shrew *Crocidura suaveolens* Pallas, 1811	4	River forest	T09
2	Small five-toed jerboa *Allactaga elater* (Lichtenstein, 1825)	8	Mountain steppe with rocky outcrops	T08
3	Libyan jird *Meriones libycus* Lichtenstein, 1823	35	Rocky mountain, mountain foothills, river forest	T01, T07, T09
4	Midday jird *Meriones meridianus* (Pallas, 1773)	4	River forest	T09
5	Grey dwarf hamster *Cricetulus migratorius* Pallas, 1773	4	Rocky mountain, mountain steppe with rocky outcrops, rocky mountain	T04, T08
6	Red fox *Vulpes vulpes* Linnaeus, 1758	52	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops river forest	T01, T03, T04, T07, T08, T09

7	Asiatic wildcat *Felis sylvestris ornate* Gray, 1830	22	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops river forest	T04, T07, T08, T09
Other species				
Reptiles				
1	Central Asian tortoise *Testudo horsfieldii*	8	Mountain steppe with rocky outcrops, river forest	T08, T09
2	Turkestan agama *Trapelus sanguinolentus,*	1	Mountain steppe with rocky outcrops	T08
3	Turkestan thin-toed gecko *Cyrtopodion fedtschenkoi*	4	Mountain foothills	T07
Birds				
1	Chukar *Alectoris chukar*	72	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops, river forest	T01, T03, T04, T07, T09
2	Little owl *Athene noctua*	6	Rocky mountain, mountain foothills	T03, T07
3	Eurasian hoopoe *Upupa epops*	1	River forest	T09
4	Crested lark *Galerida cristata*	4	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops, river forest	T03, T07, T08, T09
5	Horned lark *Eremophila alpestris*	1	Mountain steppe with rocky outcrops	T08
6	Tawny pipit Anthus campestris	1	Mountain steppe with rocky outcrops	T08
7	Streaked Scrub Warbler Scotocerca inquieta	3	Mountain foothills, river forest	T04, T09
8	Pied Wheatear Oenanthe pleschanka	8	Rocky mountain, mountain foothills	T01, T03, T04
9	Black redstart Phoenicurus ochruros	12	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops, river forest	T01, T03, T04, T08, T09
10	European Robin Erithacus rubecula	2	River forest	T09
11	Bluethroat Luscinia svecica	4	Rocky mountain, river forest	T01, T09

12	Redwing Turdus iliacus	8	Rocky mountain, river forest	T01, T09
13	Turkestan Tit Parus bokharensis	1	River forest	T09
14	Eastern Rock-nuthatch Sitta tephronota	7	Rocky mountain, mountain steppe with rocky outcrops	T01, T08
15	Rock Sparrow Petronia petronia	9	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops, river forest	T01, T03, T04, T09
16	Chaffinch Fringílla coelebs	11	Mountain foothills, river forest	T03, T09
17	Mongolian Finch Bucanetes mongolicus	2	Mountain foothills	T03
Domestic animals				
	Domestic livestock	9	Rocky mountain, mountain foothills, mountain steppe with rocky outcrops, river forest	T01, T03, T08, T09
	Domestic dogs	7	River forest	T09

All the technical details regarding camera traps locations, biotopes and status, as well as number of the nearest wind turbines that could negatively affect wild species are presented in table 2. Also there are all data regarding mammals recorded by each camera trap, including species names, number of records and record date. The largest number of mammal species was recorded on sites 09 and 08 (Muruntau ridge incl. mountain steppe with rocky outcrops and tugai forest).

Red fox at the entrance in cave in Muruntau ridge (T07 site)

Asian cat came to cave in Muruntau mountain foothills with single rocks (T07 site)

Table 3 Camera trap locations, nearest wind turbines and mammal species recorded on monitoring sites by camera traps in the project area (Aktau, Muruntau degraded mountains and pre-Zarafshan desert, Tamdy province, Navoi region, Uzbekistan) in the period of November 22, 2020 to April, 14, 2021

# Monitoring site	## turbine (s)	Coordinates, WGS-84, grade/min/sec	Altitude, m asl	Biotope	Mammals recorded in monitoring site	Number of records	Season (month, year)	Notes
T01	37, 38, 96, 97	41°39'48.6" 64°25'54.7"	408	Dry stream on big Aktau. Marble exits	Red fox, *Vulpes vulpes* Libyan jird, *Meriones libycus*	14 1	12.2020; 01.2021; 03.2021 02.2021	Camera trap removed
T03	96, 97, 98	41°37'24.3' 64°28'02.1"	630	'Black Mountain' - Niche under the rock, rock scree	Red fox*, Vulpes vulpes*	*1*	*04.2021*	Camera trap removed
T04	96, 97, 98	41°38'16.3" 64°28'00.6"	633	Rock with a golden eagle's nest	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Gray dwarf hamster, *Cricetulus migratorius*	*2* *4* *1*	*11.2020; 12.2020* *01.2021* *12.2020; 01.2021*	Camera trap serviced and re-installed
T05	43, 44, 45, 46, 79	41°35'34.4" 64°26'26.5"	753	Rock jag on the mountain.	*Red fox, Vulpes vulpes*	-	-	Camera trap didn't work by tech. reasons; re-installed Recorded Red fox scats
T06	8, 9	41°31'30.1" 64°16'07.4"	493	Dry bed under the railway. Sandy-clayey soil	Red fox, *Vulpes vulpes* Yellow ground squirrel, *Spermophilus fulvus* Midday jird, *Meriones meridianus*	-	-	Camera trap was stolen Recorded: red fox (visually); long-clawed ground squirrel (track); midday jird (tracks)

T07	87, 88	41°35'04.8" 64°27'41.5"	743	Hilly area. Rocky 'tooth' on top	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Libyan jird, *Meriones libycus*	*21* *6* *1*	*11.2020-04.2021* *12.2020-04.2021* *03.2021*	Camera trap serviced and re-installed
T08	94, 67	41°34'51.3" 64°30'36.8"	620	Mountain steppe with rocky outcrops	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Gray dwarf hamster, *Cricetulus migratorius* Small five-toed jerboa, *Allactaga elater*	*2* *1* *3* *8*	*02.2021; 04.2021* *02.2021* *02.2021* *02-04.2021*	Camera trap removed
T09	19, 20	41°31'25.1" 64°17'41.2"	505	Tugai along the stream with flowing water	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Libyan jird, *Meriones libycus* Midday jird, *Meriones meridianus* Lesser white-toothed shrew, *Crocidura suaveolens*	*12* *11* *34* *4* *4*	*12.2020-01.2021* *11.2020-03.2021* *11.2020-03.2021* *12.2020* *11-12.2020; 03.2021*	Camera trap removed

Based on the data collected by camera trapping we can conclude that biodiversity of project area is quite reach especially in mountain areas (Big and Little Aktau, Muruntau ridges) as well as fragment of tugai along the stream in Zaravshan city vicinity. These regions have relatively high biotopic diversity and the availability of food resources and good protective properties. We confirmed the presence and the status of 7 species of mammals. Unfortunately, our cameras didn't register any of *Mustelidae* species, as well as endangered representatives of *Canidae (Corsac Fox)* and *Felidae (Caracal)* families.

Results investigation of the road effect on animals

In addition, we collected data on a roadkill on a highway Navoi-Zaravshan. This gave us additional information about species composition and their relative abundance as well as the effect of the road on biodiversity.

Highways directly cause animal mortality. Small mammals, birds, reptiles and invertebrates die in large numbers (Trent et al., 2010; Irisov, 1990; Murzov, Blank, 1990; Kovshar and Gubin, 1990; Brushko, 1993; Berezovikov, 1995; Gashev et al., 2009; Bykova & Esipov, 2009, etc.). Rare species of animals often become victims of railroad and road transport (Nuridjanov, 2008; Bykova & Esipov, 2009 etc.), and there are even cases of death during seasonal migration of rare bats (Dikiy, Srebrodolskaya, 2006).

In total, 37 individuals of 8 species were recorded during the survey, including 2 species of reptiles, 1 species of birds and 5 species of mammals (table 4). The largest proportion of killed animals belong to Central Asian tortoise *Testudo horsfieldii* (40.54%) and yellow ground squirrel *Spermophilus fulvus* (35.13%). Mostly these are young, mobile individuals that died during their attempts to cross the road. The life cycle of both species is characterized by a short period of activity from March to June, then these animals start summer hibernation, smoothly turning into winter hibernation. Consequently, they can only occur in spring and early summer. Our routes passed in places characterized by a rather high abundance of both species, which explains the rather high percentage of encounters of these animals. There was also one case of accidental death of the desert monitor *Varanus griseus*.

Endangered desert monitor (on the left) and Central Asian tortoise (on the right) accidentally killed on a highway in a vicinity of Zaravshan city

Central Asian tortoise and Desert Monitor are listed in the Red Book of Uzbekistan (2019). Desert monitor spends half a year in hibernation and is active in spring like tortoise. It is attracted to the road surface heated in the sun, as well as the 'belt' colonies of the great gerbil located along the roads - the main prey of the Desert Monitor, whose burrows also serve as a shelter.

Table 4 List of the vertebrates accidentally killed on the road A379 Navoi-Zarafshan (150 km, April 12, 2021)

№	Species name	Number of killed animals	% killed animals
	Reptiles		
1	Central Asian tortoise *Testudo horsfieldi*	15	40.54
2	Desert monitor *Varanus griseus*	1	2.70
	Birds		
3	Crested lark *Galerida cristata*	2	5.40
	Mammals		
4	Long-eared hedgehog *Hemiechinus auritus*	2	5.40
5	Yellow ground squirrel *Spermophilus fulvus*	13	35.13
6	Libyan jird *Meriones libycus*	1	2.70
7	Great gerbil *Rhombomys opimus*	1	2.70
8	Red fox *Vulpes vulpes*	2	5.40
	Total	**37**	

Yellow ground squirrel (on the left) and red fox (on the right) accidentally killed by the vehicles in close vicinity of Zafavshan

Libyan jird (on the left) and long-eared hedgehog (on the right) killed on the road Navoi-Zafavshan

In our survey the highest mortality was observed for animals living near roads running along the natural landscape, which is related with richer species composition of natural biocenoses compared to the depleted fauna of urban- and agro-cenoses. However, we also recorded 4 cases when yellow ground squirrels were hit by cars in urban area on the border of Zaravshan city.

As a result of our spring surveys, we confirmed the presence and status of 17 mammalian species out of 32 species likely to appear in the project area based on our desktop study (see gray lines on table 5).

Table 5 Characteristics of mammals in the project area and adjacent areas of Tamdytau and Central Kyzylkum

№ п/п	Species	Conditional population estimate	Status of threat IUCN RedList/Uzbekistan RDB	Sources
1	Long-eared hedgehog *Hemiechinus auritus* Gmelin, 1770	O-M	LC/-	Ground survey; road accident assessment (A379 Navoi-Zarafshan)
2	Brandt's hedgehog *Paraechinus hypomelas* (Brandt, 1836)	P-E	LC/3NT	Kashkarov, 2019
3	Lesser white-toothed shrew *Crocidura suaveolens* Pallas, 1811	O-H	LC/-	Ground survey, camera trapping
4	Piebald shrew *Diplomesodon pulchellum* (Lichtenstein, 1823)	P-E	LC/-	Data by APS-Zarafshan
5	Tolai hare *Lepus totai* Pallas, 1778	O-M	-	Ground survey
6	Lesser mouse-eared bat *Myotis blythii* (Tomes, 1857)	O-H	LC/-	Bogdanov, 1953, 1991; Gritsina et al, 2013a, 2013б

7	Botta's serotine *Eptesicus bottae* (Peters, 1869)	O-H	LC/-	Bogdanov, 1953, 1991; Gritsina et al, 2013a, 2013б
8	Long-clawed ground squirrel *Spermophilopsis leptodactylus* (Lichtenstein, 1823)	O-H	LC/-	Ground survey
9	Yellow ground squirrel *Spermophilus fulvus* (Lichtenstein, 1823)	O-M	LC/-	Ground survey; road accident assessment (A379 Navoi-Zarafshan)
10	Small five-toed jerboa *Allactaga elater* (Lichtenstein, 1825)	O-M	-	Ground survey, camera trapping Data by APS-Zarafshan
11	Severtzov's jerboa *Allactaga severtzovi* Vinogradov, 1925	O-H	LC/-	Data by APS-Zarafshan
12	Northern three-toed jerboa *Dipus sagitta* (Pallas, 1773)	O-H	LC/-	Data by APS-Zarafshan
13	Great gerbil *Phombomys opimus* (Lichtenstein)	O-M	LC/-	Ground survey; road accident assessment (A379 Navoi-Zarafshan); Data by APS-Zarafshan;
14	Libyan jird *Meriones libycus* Lichtenstein, 1823	O-M	LC/-	Ground survey; camera trapping; road accident assessment (A379 Navoi-Zarafshan)
15	Midday jird *Meriones meridianus* (Pallas, 1773)	O-M	LC/-	Ground survey, camera trapping
16	Grey dwarf hamster *Cricetulus migratorius* Pallas, 1773	O-H	LC/-	Ground survey, camera trapping
17	Zaisan Mole Vole *Ellobius tancrei* Blasius, 1884	O-M	LC/-	Ground survey
18	Carruther's vole *Microtus (Neodon) carruthersi* Thomas, 1909	O-H	-/-	Ground survey
19	*Mus musculus* Linnaeus, 1758	O-H	-/-	Ground survey
20	Grey wolf *Canis lupus* (Linnaeus, 1758)	P-E	LC/-	Data by APS-Zarafshan
21	Corsac Fox *Vulpes corsac* (Linnaeus, 1768)	P-E	LC/2(VU:D)	Mitropolskaya, 2019

22	Red fox *Vulpes vulpes* Linnaeus, 1758	O-M	LC/-	Ground survey; camera trapping; road accident assessment (A379 Navoi-Zarafshan)
23	Weasel *Mustela nivalis* Linnaeus, 1766	O-H	LC/-	Data by APS-Zarafshan
24	Marbled Polecat *Vormela peregusna* (Güldenstädt, 1770)	P-E	VU/2(VU:D)	Data by APS-Zarafshan
25	Steppe Polecat *Mustela eversmanii* Lesson, 1827	P-E	LC/2(VU:D)	Mitropolskaya, Kashkarov, 2019
26	Asian Badger *Meles leucurus* (Hodgson, 1847)	P-E	LC/-	Ground survey
27	Asiatic wildcat *Felis sylvestris ornate* Gray, 1830	O-M	-	Ground survey, camera trapping
28	Sand cat *Felis margarita* Loche, 1858	P-E	LC/3NT	Data by APS-Zarafshan; Gritsina, 2019
29	Caracal *Caracal caracal* (Schreber, 1776)	P-E	LC/1(CR)	A.S. Nuridjanov pers. comm., 2005; Gritsina et al., 2016; Gritsina, 2019
30	Wild boar *Sus scrofa* Linnaeus, 1758	O-H	LC/-	Data by APS-Zarafshan
31	*Ovis ammon* (Linnaeus, 1758) ssp. *severtzovi* Nasonov, 1914	P-H	NT/2(VU:D)	Beshko, 2019
32	Goitered Gazelle *Gazella subgutturosa* (Güldenstädt, 1780)	P-H	VU/3(VU)	Ground survey; Data by APS-Zarafshan; Marmazinskaya, Gritsina, 2017; Marmazinskaya, 2019

Notes: *Conditional estimate of the number: E - single, H - few, M - Numerous; O - common, R - rare. IUCN Red List categories: Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threat (NT); Least concern (LC); Data Deficient (DD); Categories of the Red Data Book of the Republic of Uzbekistan (2019): Extinct 0 (EX); Extinct in the Wild 0 (EW); Critically Endangered 1 (CR); Endangered 1 (EN); Vulnerable 2 (VU: D); Naturally Rare 2 (VU: R); Near Threat 3 (NT); Data Deficient (DD).*

CONCLUSIONS

Natural habitats for biodiversity are territories located at some distance from settlements and infrastructure facilities. The mountain ridges and foothills of Big and Small Aktau are one of them. The endangered *Goitered gazelle* and economically important mammals (*Asiatic wild cat, Red fox*, etc.) inhabit here. Turbines ## 37, 38, 67, 96, 97 and 98 are planned to be installed closest to this area. Livestock, recreation and marble mining also effect this area, but only locally. In general, the status of mountain and foothill ecosystems in Aktau is assessed as satisfactory.

Also, wild animals are concentrated in the Muruntau ridge system in places with rock outcrops that have good feeding and protective properties. It is planned to install turbines ## 43, 44, 45, 46, 67, 79, 88, 94 and 97 not far from these areas.

The foothills of Muruntau in the vicinity of Zaravshan are also quite rich in terms of the mammal diversity. Turbines No. 19, 20 are going to be installed here. This area is already under very strong pressure from the anthropogenic factors. Very well known Muruntau mine is one of the largest gold mines in Uzbekistan and in the world.

In addition to influence of mining and urbanization, local people use this region for seasonal grazing of livestock. All of this effect wildlife leading habitat degradation, fragmentation and loss, species disturbance and extinction. In addition, roads and, possibly, railways have a negative impact on nature. More likely, the wind farm will increase the degree of negative anthropogenic influence, especially during the construction period. Therefore, it is not recommended to install turbines near the Aktau ridge, and it is necessary to apply principles of mitigation hierarchy: avoidance, minimization, and only if these are not applicable, restoration and offset for impacted areas in Muruntau regions. It is also recommended to develop and install a system of warning road signs to prevent the death of animals on the roads located near the project area (A379 Navoi-Zarafshan).

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Appendix 1. CAMERA TRAPS RECORDS OF MAMMALS AND SOME OTHER SPECIES

Libyan jird in river forest (T09 site)

Asian cat in river forest (T09 site)

Lesser white-toothed shrew in togai forest (T09 site)

Red fox in in Big Aktau mountain ("marbled river") (T01 site)

Gray dwarf hamster in Small Aktau mountain (T04 site)

Central Asian tortoise in Muruntau mountain (T08 site)

Chukars in tugai forest (T09 site) and Aktau mountain (T04 site)

Little owl in Small Aktau (T03 site)

Eastern Rock-nuthatch in Big Aktau (T01 site)

Horned larks in Muruntau - boreal bird rarely recorded in Uzbekistan (T08 site)

Mongolian Finch in Small Aktau – boreal bird rarely recorded in Uzbekistan (T03 site)

Table 1 – Mammals recorded in monitoring sites by camera traps in the project area (Aktau, Murumtau degraded mountains and pre-Zerafshan desert, Tamdy province, Navoi region, Uzbekistan) in November 22, 2020-April, 14, 2021 (6 camera traps; 854 camera traps / days; 3349 total captures and 753 effective captures with animals records incl. mammals, birds and reptilians)

# Monitoring site	## turbine (s)	Coordinates, WGS-84, grade/min/sec	Altitude, m asl	Biotope	Mammals recorded in monitoring site	Number of records	Season (month, year)	Notes
T01	37, 38, 96, 97	41°39'48.6'' 64°25'54.7''	408	Dry stream on big Aktau. Marble exits	Red fox, *Vulpes vulpes* Libyan jird, *Meriones libycus*	14 1	12.2020; 01.2021; 03.2021 02.2021	Camera trap removed
T03	96, 97, 98	41°37'24.3' 64°28'02.1''	630	'Black Mountain' - Niche under the rock, rock scree	Red fox, *Vulpes vulpes*	*1*	*04.2021*	Camera trap removed
T04	96, 97, 98	41°38'16.3'' 64°28'00.6''	633	Rock with a golden eagle's nest	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Gray dwarf hamster, *Cricetulus migratorius*	*2* *4* *1*	*11.2020; 12.2020* *01.2021* *12.2020; 01.2021*	Camera trap serviced and re-installed
T05	43, 44, 45, 46, 79	41°35'34.4'' 64°26'26.	753	Rock jag on the mountain.	*Red fox, Vulpes vulpes*	-	-	Camera trap didn't work by tech. reasons; re-installed

		5''						Recorded Red fox scats
T06	8, 9	41°31'30.1" 64°16'07.4"	493	Dry bed under the railway. Sandy-clayey soil	Red fox, *Vulpes vulpes* Long-clawed ground squirrel, *Spermophilus fulvus* Midday jird, *Meriones meridianus*	-	-	Camera trap was stolen Recorded: red fox (visually); long-clawed ground squirrel (track); midday jird (tracks)
T07	87, 88	41°35'04.8" 64°27'41.5"	743	Hilly area. Rocky 'tooth' on top	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Libyan jird, *Meriones libycus*	*21* *6* *1*	*11.2020-04.2021* *12.2020-04.2021* *03.2021*	Camera trap serviced and re-installed
T08	94, 67	41°34'51.3" 64°30'36.8"	620	Mountain steppe with rocky outcrops	Red fox, *Vulpes vulpes* Asian wildcat, *Felis silvestris ornate* Gray dwarf hamster, *Cricetulus migratorius* Small five-toed jerboa, *Allactaga elater*	*2* *1* *3* *8*	*02.2021; 04.2021* *02.2021* *02.2021* *02-04.2021*	Camera trap removed
T09	19, 20	41°31'25.	505	Tugai along the stream with	Red fox, *Vulpes vulpes*	*12*	*12.2020-01.2021*	Camera trap

		1'' 64°17'41.2''		flowing water	Asian wildcat, *Felis silvestris ornate* Libyan jird, *Meriones libycus* Midday jird, *Meriones meridianus* Lesser white-toothed shrew, *Crocidura suaveolens*	*11* *34* *4* *4*	*11.2020-03.2021* *11.2020-03.2021* *12.2020* *11-12.2020; 03.2021*	removed

Juru Energy

HERPETHOLOGICAL SURVEY

ZARAFSHAN WIND FARM PROJECT:

CLIENT: WOOD GROUP

Date: June 2021

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Contents

INTRODUCTION 2
HISTORY OF THE STUDY OF THE REGION 3
PHYSIOGRAPHICAL DESCRIPTION OF THE RESEARCH AREA 4
CLIMATE, WATER, SOIL AND VEGETATION 6
METHODS OF CONDUCTING HERPETOLOGICAL FIELD SURVEY 8
RESULTS 10
RESULTS OF THE FIELD TRIP IN APRIL 2021 11
CONSTRUCTION-RELATED THREATS 16
RECOMMENDATIONS 16
SOURCES OF INFORMATION 18
Appendix 1 20

INTRODUCTION

Uzbekistan is located in the central part of Central Asia and has common borders with five countries - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Afghanistan in the south. This geographical location at the junction of a number of biogeographic regions determines the antiquity, diversity, origin and complex genetic relationships of flora and fauna. The gene pool of wild animals inhabiting the territory of the Republic of Uzbekistan is unique. Our country is an important habitat for endemic species and subspecies of animals of Central Asian origin. Most of it is represented by native fauna (Yunusov et al., 2015).

Nowadays, it becomes increasingly clearer that sustainable nature management is the only right way for the further development of humanity.

One of such sustainable approaches is the introduction and use of alternative energy sources.

It should be noted that Resolution No. UP-5544 "On Approval of the Strategy of Innovative Development of the Republic of Uzbekistan for 2019-2021" (President of the Republic of Uzbekistan, 21 September 2018) prescribes an increase in the portion of electric energy production using renewable energy sources to the level of at least 20% by 2025.

In addition, Resolution No. PP-4422 "On accelerated measures to improve the energy efficiency of economic and social sectors, introduce energy-saving technologies and develop renewable energy sources" (President of the Republic of Uzbekistan, 22 August 2019) approves long-term target parameters for the development of renewable energy sources and organisational and practical measures for further development of renewable energy sources.

This resolution prescribes an increase in the portion of electricity production using renewable energy sources to at least 25% by 2030.

To achieve these targets, the government has developed a plan to build almost 10 GW of new renewable energy facilities, including 5 GW of solar (excluding the capacity of individual households), 3 GW of wind and 1.9 GW of hydroelectric power plants.

At the same time, the construction of new renewable energy facilities with a total capacity of more than 10 GW and the modernization of existing hydroelectric power plants will ensure the production of more than 37 billion kWh of electricity by renewable energy facilities (in 2018 – 5.9 billion kWh), as well as expected annual savings of more than 8.1 billion m^3 of natural gas.

This report provides a faunal overview of the area designed for the construction of wind power plant in Navoi region, in the foothills of Tamdytau and Muruntau residual (island) mountains.

This report also provides historical background and data obtained during the field trip from April 14 to April 18, 2021.

HISTORY OF THE STUDY OF THE REGION

The history of the study of reptiles inhabiting the territory of Uzbekistan, as was the case with other vertebrates in Central Asia, began with the trip of E. A. Eversmann and K. Pander from Orenburg to Bukhara (October 1820 – April 1821). The few and occasional collections of E. A. Eversmann, transferred to the University of Berlin, were processed by Prof. G. Lichtenstein and published in 1823 as an appendix to the work of E. A. Eversmann (Bogdanov, 1960).

A. P. Khoroshkhin left Jizzakh in April 1872 and drove along the foot of the Nuratau Range and past the Aristan-Beltau mountains, and arrived in Tamdy, from where he travelled to the Aktau and Bukantau mountains. However, A. P. Khoroshkhin was not a specialist and did not collect reptiles, and in the book published in 1876 he mentioned only a tortoise, monitor lizard and sand racer.

G. Ye. Grum-Grzhimailo travelled across Uzbekistan with his expedition in 1885 (see Fauna of the Uzbek SSR, vol. II). His collections were processed by A. M. Nikolsky (1915).

The book by A. M. Nikolsky 'Reptiles and amphibians of the Turkestan general-governorship' is a complete literary summary of that time, was published in 1899. The author processed the materials of A. P. Fedchenko and others who collected them in Central Asia. The paper provides information on the distribution of 7 species of amphibians, 3 species of tortoises, 42 species of lizards and 28 species of snakes. Of these, 2 species of amphibians, 1 tortoise species and more than half of the species of lizards and snakes were caught in the territory of Uzbekistan (Sultanov, Persianova, 1982).

In 1933, 1934 and 1935 A. M. Andrushko collected in the central part of Kyzylkum more than 700 individuals of reptiles. Her article published in 1953 lists 23 species and specifies their distribution across biotopes. 7 species of reptiles (Transcaspian bent-toed gecko, Turkestan thin-toed gecko, Reticulated toad-headed agama, Striped racerunner, Tatary sand boa, Spotted whip snake, Diadem snake) were for the first time discovered in this part of the desert.

O. P. Bogdanov in his work "Fauna of the Uzbek SSR. Amphibians and reptiles" (1960) provides data that he collected in Central Kyzylkum in 1949, 1950, 1954 and 1955.

N. N. Shcherbak (1974) studied racerunners (genus *Eremias*) throughout their habitat, including the central part of Kyzylkum, in particular, in the area near the towns of Zaravshan and Uchkuduk.

The publication of D. A. Bondarenko and E. A. Peregontseva (2017) describes the spatial distribution of the Russian tortoise *Testudo horsfieldii* in Uzbekistan, mostly in the central part of the Kyzylkum desert.

Also, this report presents the author's personal data collected during field studies of the area in 2012, 2014, 2015, 2018 and 2019.

The list of reptiles is given according to the latest updated reptile database

(http://www.reptile-database.org/data/Reptile_checklist_2019_07.xlsx.)

PHYSIOGRAPHICAL DESCRIPTION OF THE RESEARCH AREA

The Kyzylkum physiographical region (Fig. 1) is located almost in the very center of the flat part of Central Asia, which is associated with truly desert landscape. It includes the western part (belonging to Uzbekistan) of the Kyzylkum Desert (its northern and eastern parts are on the territory of Kazakhstan). In the north lies the border of the region with Kazakhstan, in the south-west – with Turkmenistan, in the east is the Mirzachul area, in the south-east – the Zarafshan area and in the west – the lower Amudarya area (Gulomov et al., 2013).

The surface of the area slopes slightly down from south-east to north-west. The average altitude above sea level is 200-300 m, in the south-east the heights reach 350-400 m, in the north-west – only 100 m. The lowest point is the Mingbulak depression 12 m below sea level. The highest point is Aktau peak (922 m) in the Tamdytau Mountains (Gulomov et al., 2013).

The Kyzylkum Desert in the north-west is bordered by the Aral Sea, in the north-east by the Syr Darya, in the east by the spurs of the Tien Shan and Pamir Alai, in the south-west by the Amu Darya. The area of the desert is about 300 thousand square kilometers (Yugai, 1964).

Fig 1. Satellite image with the territory of the Kyzylkum desert highlighted (Wikipedia, source file: Whole world – land and oceans.jpg)

The Kyzylkum Desert is a plain generally sloping to the north-west (altitudes above sea level range from 300 meters in the south-east to 53 meters in the northwest); it has a number of closed depressions and highly dissected isolated residual (island) mountains – Bukantau (764 m), Kuldzhuktau (up to 785 m), Tamdytau (922 m) and others, composed of strongly dislocated and metamorphosed Paleozoic shales, hornstones, limestones, granites. (Yugai, 1964). The mountains are barren and mostly have levelled peaks and rocky, heavily cut slopes. Between these mountains are the Mingbulak, Karakata, Mullali and Ayakagitma depressions. The lower parts of these depressions are occupied by *solonchaks*, *takyrs* and sands (Gulomov et al., 2013).

Most of the desert is occupied by extensive sandy areas composed of semi-fixed sands. The most widespread are meridionally-oriented sandy ridges. The relative height of the ridges is from 3 to 30 m, with a maximum of up to 75 m. The flat portions are composed of Cenozoic clays and sandstones, in the north and north-west – loamy and mixed sandy and loamy river sediments. A characteristic feature of the Kyzylkum desert is the existence in its central and south-western parts of isolated low mountains – residual (island) mountains. These are Bukantau, Dzhetymtau, Tamdytau, Kuldzhuktau, as well as Sultanuizdag in the west. All of them are remnants of Paleozoic (Hercynian) folded

chains located on the continuation of the structures of the northern chains of the Pamir-Alai (Turkestan and Nuratau Ranges) and formed by the latest tectonic processes. The elevations are composed of highly dislocated and metamorphosed Paleozoic slates, limestones and granites. The tops and crests of many of the residual (island) mountains have levelled surfaces used for unirrigated farming. The slopes of the residual (island) mountains are strongly dissected; at the feet there are aprons composed of pebbly and sandy accumulations, which often contain fresh groundwater and in some places feed the springs that supply mining villages with water. The area of the residual (island) mountains also features flat hilly elevations and plateaus of the cuesta type, composed of slightly disturbed Cretaceous and Paleogene sedimentary rocks (marls, sands, clays). Another characteristic feature is the existence of extensive closed basins (the Karakat and Ayakagytma basins) in the central and south-western parts of the desert (Gulomov et al., 2013).

Loose sand dunes are found near human settlements and around wells. In most cases, the exposure of the sands is the result of excessive grazing and trampling of vegetation by livestock near watering holes, as well as the use of shrubs and saxaul for fuel (Gulomov et al., 2013).

Sheep and goats, as well as camels and horses and, to a lesser extent, cattle graze in the Kyzylkum desert. The organization of pasture use and the creation of new wells made it possible to significantly increase the livestock population (Gulomov et al., 2013).

Large artesian basins were discovered in the central and south-western parts of the desert. Agriculture is beginning to develop near artesian wells in depressions, where melons and pumpkins are cultivated and experimental stations are established to provide livestock with additional feed (Gulomov et al., 2013).

CLIMATE, WATER, SOIL AND VEGETATION

The climate of the Kyzylkum physiographical region is arid and sharply continental. It is characterized by high summer temperatures, a very low level of annual precipitation and a strong fluctuation of daily and annual temperatures (Gulomov et al., 2013).

Winter in Kyzylkum is cold. The reason for this is the frequent invasions of dry and cold Arctic air masses and the Siberian anticyclone from the north. On such days, the air temperature drops sharply to –31–35 ° C. Western air masses bring precipitation and a slight increase in temperature. The average temperature in January in the north of Kyzylkum is –5–10 ° C, in the middle part –2–4 ° C, in the south –1–2 ° C (Gulomov et al., 2013).

With the coming of spring, the temperature gradually rises and rainfalls become quite frequent. Nature awakens and the earth becomes covered with ephemeral plants. The precipitation season is already over in April. In the long summer period (lasts more than 150 days), the air temperature is the same almost throughout. This is due to the large amount of solar radiation (total annual radiation is 120 kcal per 1 cm^3) and the penetration of hot tropical air masses from the south. The average temperature in the

southern and central parts is + 30 °, in the north + 26 + 28 ° C; on some days the temperature reaches + 48 ° C. At this time, the sands warm up to +75 + 80 ° C.

Autumn in Kyzylkum is usually dry. There is little precipitation (up to 75–100 mm annually), and it is unevenly distributed over the seasons. The largest portion of the annual amount of precipitation falls in spring (up to 48%) and winter (up to 30%), but the evaporation rate reaches 1,000–1,500 mm (Gulomov et al., 2013).

The region has a significant stock of groundwater. The dynamic amount of groundwater is 58–60 m^3/sec. The groundwater is salty. Fresh artesian waters are available in the strata of the Mesozoic and Paleogene sediments. Also, mineral thermal waters were found in the Paleozoic deposits (Gulomov et al., 2013).

In Kyzylkum, sandy and mixed sandy and loamy soils are widespread in the plains, foothills and on the slopes of the elevations – grey-brown soils, and in the basins – solonchak and marshy solonchak soils (Gulomov et al., 2013).

More than 600 plant species grow in the Kyzylkum area. They are dominated by ephemerals and ephemeroids with a short spring growing season: bulbous bluegrass, sedge, Bromus danthoniae, tulips, snowdrops, Ixiolirion, Cousinia microcarpa. When the hot season sets in, they wither. Plants adapted to droughts and solonchaks continue to grow in summer (Gulomov et al., 2013).

Calligonum, white saxaul, Stipagrostis, sand acacia inhabit fixed sands. Sagebrush and weed widely occur on grey-brown soils (Gulomov et al., 2013).

Black saxaul, tamarisk, Climaooptera crassa, Halocnemum grow on solonchak and solonchak-marshy soils, Gamanthos – on takyr (Gulomov et al., 2013).

METHODS OF CONDUCTING HERPETOLOGICAL FIELD SURVEY

During the field survey an attempt was made to assess the status of reptiles and amphibians in the study area (specification of the species and quantitative composition, territorial distribution, including places of concentration, the state of habitats). However, it should be noted that cold weather did not allow for a full survey in this area, while single records of reptiles do not give a complete understanding of the composition of the biodiversity in the area. Therefore, the combination of field survey and desktop analysis was used.

Field studies were carried out according to generally accepted zoological methods for identifying species composition. The following methodological guidelines were used in the survey: L. G. Dinesman, M. L. Kaletskaya (1978), V. M. Makeev, A. T. Bozhansky (1988) and N. N. Shcherbak (1989), D. A. Bondarenko, Chelintsev, (1996). Literature sources and statistical data had been processed.

The main research method used was mixed stationary and transect survey. Points and transects for conducting research were outlined at the project monitoring stations in accordance with different types of habitats.

The field research methodology reflects the following aspects:

- species composition in the study area;

- distribution across habitats;

- daily and seasonal changes in activity;

Thus, the method of quantitative assessment was based on the ecology of the species under consideration, landscape and geographical conditions, season and type of work.

The quantitative assessment of reptiles and amphibians was mainly based on the transect survey. The transect method consists in counting individuals along a fixed long line (transect), on both sides of it, with the duration of the survey determined by the known distance, which is selected depending on the type of reptile and the area, but does not exceed 1 km in one way. In this case, all individuals encountered on the transect are registered, regardless of the distance they are identified at. The perpendicular distance is measured between the transect axis and each individual. The results obtained are used to calculate the density of recorded reptiles. The one-kilometer transect was chosen because heaviest errors arise when long transects are used for species that, like the Russian Tortoise, have high density, daily and seasonal activity cycles fluctuations with high peak values, and are caused by incorrect selection of a minimum survey area for a particular species (Vashetko et al, 2001).

The Russian tortoise population density (***D***) was calculated using the following formula (Bondarenko, Chelintsev, 1996):

$$\boldsymbol{D = \frac{n}{2LB}}$$

where ***n*** – number of animal individuals recorded on the transect; ***L*** – length of the transect; ***B*** – formula to calculate an effective width of the survey strip:

$$\boldsymbol{B = W(0,79F + 0,21F^4)}$$

where ***W*** – width of the limited strip on both sides of the transect axis; ***F****:*

$$\boldsymbol{F = \frac{2y}{W}}$$

Formula to calculate a relative statistical error ***e(D)***:

$$\boldsymbol{e(D) = \frac{1,25 + 0,1F}{\sqrt{k}}}$$

where ***k*** – number of records of individuals on the transect.

The use of perpendicular distances to carry out survey on a strip of limited width excludes underestimation of the population density of the Russian tortoise caused by a decrease in their detectability in remote parts of the survey strip, regardless of the degree of its limitation (Bondarenko and Chelintsev, 1996).

The abundance of the Russian tortoise in its habitats is estimated using the following population density scale for 1 ha (Kuzyakin, 1962): 0.1 – 0.9 – rare, 1.0 – 9.9 – common, 10.0 and higher – abundant.

RESULTS

The list of the herpetofauna of the study area is based on the modern list of representatives of the amphibian fauna of Uzbekistan, consisting of 3 species from two families, and the list of reptile species of Uzbekistan, consisting of 62 species from 13 families.

According to processed information, the author's personal data and field survey results, currently, the wind power plants construction site is inhabited by 1 amphibian species and 12 reptile species belonging to 7 families (Table 1). As we analysed the data obtained during the April 2021 field trip, we removed a number of species not typical of the biotopes presented in the project area from the table of the previoys report (2020). The following species were removed from the table: Southern Even-fingered Gecko, Derafshi Snake and Karaganda pit viper. However, Aralo-Caspian racerunner has been recorded in the project area and added to the table. The total number of amphibian species comprises 25% of the total diversity of the amphibian fauna of Uzbekistan, reptiles – 19.3%. Among them, 4 species are included in the Red Book of the Republic of Uzbekistan (2019) (33.3% of the total number of species inhabiting the project area), 1 species are included in the Red List of the International Union for Conservation of Nature (IUCN Red List) (8.3% of total number of species inhabiting the project area) and 4 species – in the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (33.3% of the total number of species inhabiting the project area).

Table 1. List of reptile species inhabiting the project territory

No.	Species name	Species name acc. to literary sources	Author's earlier personal data	October 2020 field expedition data	April 2021 field expedition data	Endemism	Nature conservation status		
							UzRDB	IUCN	CITES
Family *Bufonidae* (toads)									
1	Turan Toad *Bufotes turanensis*	**+**			+	UZ, TJ, TM			
Family *Testudinidae* (tortoises)									
1	Russian tortoise *Testudo horsfieldii*	+	+		+		2 (VU)	VU	II
Family *Gekkonidae* (geckoes)									
2	Turkestan thin-toed gecko *Tenuidactylus fedtschenkoi*	+	+		+	UZ, TJ, TM, KZ			
Family *Agamidae* (agamas)									
3	Steppe agama *Trapelus sanguinolentus*	+	+		+				
4	Sunwatcher toad-headed agama	+	+	+	+				

	Phrynocephalus helioscopus								
Family *Lacertidae* (true lizards)									
5	Rapid lizard *Eremias velox*	+	+		+				
6	Aralo-Caspian racerunner *Eremias intermedia*	+			+				
Family *Varanidae* (monitor lizards)									
7	Caspian Monitor *Varanus griseus caspius*	+	+				2 (VU:D)		I
Family *Boidae* (Boas)									
8	Desert sand boa *Eryx miliaris*	+					3 (NT)		II
9	Tatary sand boa *Eryx tataricus*	+					3 (NT)		II
Family *Colubridae* (colubrid snakes)									
10	Sand racer *Psammophis lineolatus*	+	+						
11	Spotted whip snake *Hemorrhois ravergieri*	+		+	+				
12	Spotted desert racer *Platyceps karelinii*	+	+						

Notes to Table 1: UzRDB– species/subspecies listed in the Red Data Book of Uzbekistan (2019) (CR – critically endangered; VU – vulnerable; NT – near-threatened); IUCN – species included in the Red List of the International Union for Conservation of Nature (VU - vulnerable; NT – near-threatened); CITES I, II – species listed in the appendices (I, II) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora; Endemism: AF - Afghanistan, KZ – Kazakhstan; TM – Turkmenistan; KG – Kyrgyzstan; TJ – Tajikistan; UZ – Uzbekistan.

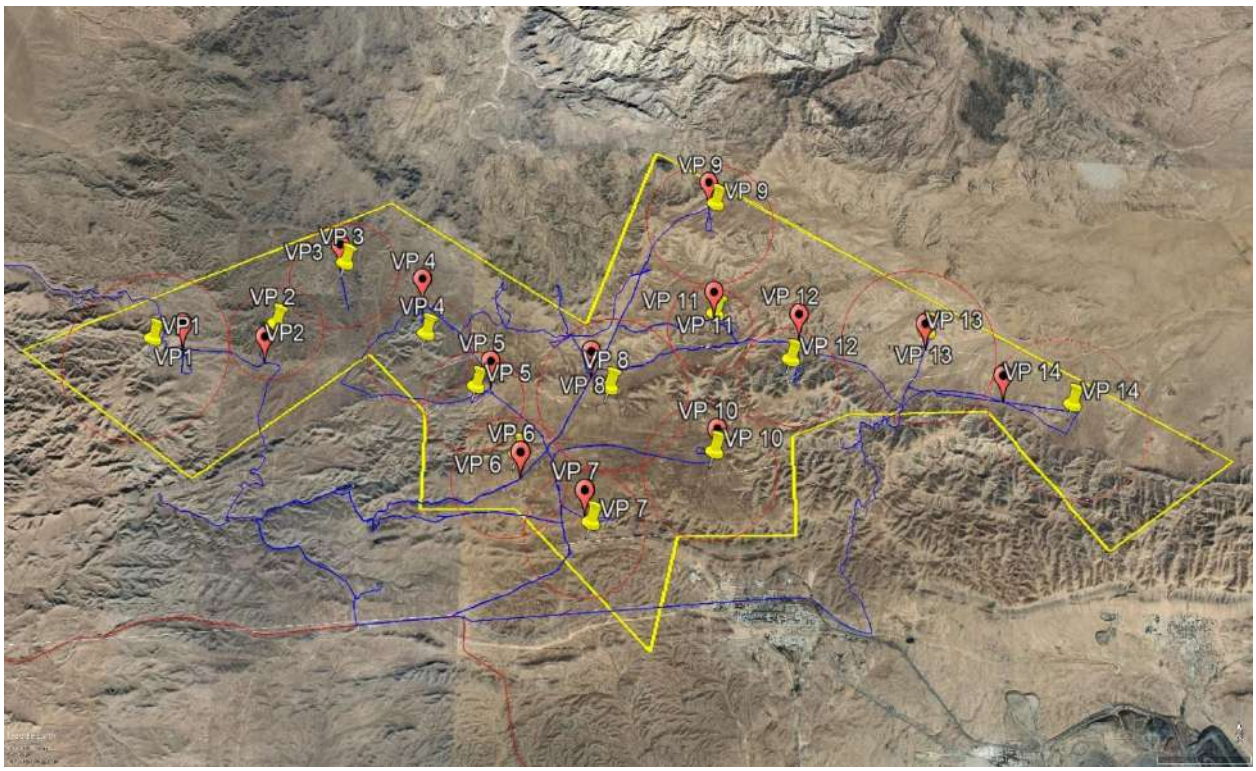
RESULTS OF THE FIELD TRIP IN APRIL 2021

The field trip to the project area was made between 14 and 18 April 2021.

A hygro-thermometer Nasedal with an elongated indicator was used to measure air temperature and humidity and a non-contact infrared thermometer DT-8380 to measure the temperature of a substrate. Visual records were made with the use of a digital camera Nikon D-7200 with a wide-angle lens AF-S NIKKOR 18-200mm 1:4,5-5,6 G ED VR and an ultra-telephoto lens Tamron 150-600mm G2.

During the survey in April 2021 we recorded 1 amphibian and 7 reptile species, 1 of which (Russian tortoise) is listed in the Red Data Book of Uzbekistan and 4 are commercial species (Table 1).

This time of the year is the breeding season for amphibians and reptiles and the period when most species go out of hibernation, and thus this is the most favourable time for surveying this group of animals.



Map 1. Survey points and transects on the territory of the projected Zarafshan wind farm in Navoi Province

Table 2. Results of the monitoring of reptiles and amphibians on the project territory during a field trip in April 2021

No	Species	No. of recorded animals	Population density on the site, inds/ha	Biotope	Transect length	Date and time	Air temperature	Soil temperature	Humidity, %
VP 1 N 41.58343° E 64.32931°				Undulating intermontane area, sagebrush association	1 km	15 April 2021	C21.9º	C30.9º	29%
1	*Bufotes viridis* Green toad	1	-						
2	*Testudo horsfieldii* Russian tortoise	3	0.46						
3	*Hemorrhois ravergieri* Spotted whip snake	1	-						
VP 2 N 41.580594° E 64.352922°				Gravelly-clayey foothills, sagebrush association	1 km	17 April 2021	C21.5º	C23.0º	21%
1	*Tenuidactylus fedtschenkoi* Turkestan thin-toed gecko	2	0.4						
2	*Trapelus sanguinolentus* Steppe Agama	1	1						
3	*Eremias velox* Rapid Lizard	2	1						
VP 3 N 41.600777° E 64.371700°				Undulating intermontane area, sagebrush association	1 km	15 April 2021	C24.8º	C30.6º	21%
1	*Testudo horsfieldii* Russian tortoise	3	0.72						
2	*Tenuidactylus fedtschenkoi* Turkestan thin-toed gecko	2	0.4						
VP 4 N 41.593023° E 64.396120°				Low mountains with gentle slopes and rocky outcrops, sagebrush association	1 km	15 April 2021	C24.3º	C33.9º	20%
1	*Testudo horsfieldii* Russian tortoise	2	1.4						

2	*Trapelus sanguinolentus* Steppe Agama	2	2						
3	*Eremias velox* Rapid Lizard	1	0.5						
VP 5 N 41.575286° E 64.416701°				Low mountains with gentle slopes, sagebrush association	1 km	15 April 2021	C23.0º	C23.3º	19%
1	*Testudo horsfieldii* Russian tortoise	2	0.72						
2	*Phrynocephalus helioscopus* Sunwatcher toad-headed agama	3	1.5						
VP 6 N 41.556951° E 64.425778°				Low mountains with gentle slopes, sagebrush association	1 km	16 April 2021	C17.6º	C15.3º	32%
1	*Testudo horsfieldii* Russian tortoise	3	1.03						
2	*Trapelus sanguinolentus* Steppe Agama	1	1						
VP 7 N 41.549502° E 64.443313°				Low mountains with gentle slopes, sagebrush association	1 km	16 April 2021	C22.6º	C26.6º	21%
1	*Testudo horsfieldii* Russian tortoise	1	1.5						
2	*Trapelus sanguinolentus* Steppe Agama	1	1						
VP 8 N 41.577268° E 64.444576°				Low mountains with gentle slopes, sagebrush association	1 km	16 April 2021	C18.7º	C17.3º	30%
1	*Testudo horsfieldii* Russian tortoise	6	1.38						
2	*Phrynocephalus helioscopus* Sunwatcher toad-headed agama	3	1.5						
3	*Trapelus sanguinolentus* Steppe Agama	1	1						
4	*Eremias intermedia* Aralo-Caspian racerunner	1	0.5						
VP 9 N 41.614249°				Low mountains with gentle slopes, sagebrush	1 km	16 April 2021	C21.6º	C25.7º	24%

E 64.478096°				association					
1	*Testudo horsfieldii* Russian tortoise	7	10.2						
2	*Phrynocephalus helioscopus* Sunwatcher toad-headed agama	2	1						
VP 10 N 41.561473° E 64.479075°				Low mountains with gentle slopes, sagebrush association	1 km	16 April 2021	C20.3º	C22.4º	27%
1	*Testudo horsfieldii* Russian tortoise	2	1.39						
VP 11 N 41.590030° E 64.478997°				Intermontane clayey plain, sagebrush-ephedra-Halocnemum association	1 km	16 April 2021	C23.7º	C44.9º	24%
1	*Testudo horsfieldii* Russian tortoise	6	3.49						
2	*Tenuidactylus fedtschenkoi* Turkestan thin-toed gecko	2	0.4						
3	*Eremias velox* Rapid Lizard	3	1.5						
VP 12 N 41.585597° E 64.502837°				Intermontane clayey plain, rocky outcrop, small valley with basins with water. Almond-ephedra-sagebrush association	1 km	16 April 2021	C23.1º	C41.0º	21%
1	*Testudo horsfieldii* Russian tortoise	7	5.65						
2	*Tenuidactylus fedtschenkoi* Turkestan thin-toed gecko	5	1						
VP 13 N 41.583726° E 64.538251°				Intermontane clayey plain, sagebrush association	1 km	16 April 2021	C29.1º	C40.4º	18%
1	*Testudo horsfieldii* Russian tortoise	25	14.95						
2	*Phrynocephalus helioscopus* Sunwatcher toad-headed agama	2	1						
VP 14 N 41.572923°				Intermontane clayey plain, sagebrush	1 km	16 April 2021	C25.4º	C37.2º	20%

E 64.558658°				association					
1	*Testudo horsfieldii* Russian tortoise	13	4.25						

It should be noted that the Russian tortoise, a species from the Red Data Book of Uzbekistan, was recorded on 13 of the 14 locations (Map 1). The largest number of individuals of this species was recorded at VP-13 – 25 individuals on a 1-km transect (a density of 14.95 inds/ha) (Table 2).

Another common species on the project territory was the Steppe agama, which we encountered at 5 of the 14 locations. Other species we often encountered on that territory were the Sunwatcher toad-headed agama and Rapid lizard. Turkestan thin-toed gecko was recorded on almost all steep slopes and rocky outcrops and near man-made structures.

CONSTRUCTION-RELATED THREATS

1. The development of natural habitats for many species of reptiles (including rare ones) may cause the population loss;
2. Animals (insects, amphibians, reptiles, birds, mammals) can get into the pit and trenches dug for the construction purposes, which can lead to their injury and death. These trenches are especially dangerous for the Russian tortoise;
3. Changing the existing relief will lead to partial loss of the habitats for animals inhabiting the project area;
4. If the construction work is begun in the winter season, part of the population of reptiles (including rare ones) being in hibernation in the ground may die;
5. Linear structures connected to the construction site will also pose threat to the life of most reptiles, especially Russian tortoise and Caspian Monitor.

RECOMMENDATIONS

Safety and environmental protection must be priorities in any activity, for which it is necessary, after assessing potential threats, in this case to biodiversity, to make efforts to carry out activities aimed at minimizing potential damage. In this regard, we recommend the following actions:

1. Seasonality of work. The construction work must take into consideration the reptiles' activity features. That is, it is advisable that all construction work should be carried out at a time when all reptiles have come out of hibernation (winter dormancy). In this period, reptiles do not have permanent burrows and can leave the construction site in advance. If the work is begun in the hibernation period, underground wintering chambers can be damaged and then the reptile is doomed to death.

2. Construction works must be carried out strictly within the territory designated for the purpose.
3. All trenches must be levelled (filled with earth) after the termination of the construction; trenches should not be used as barriers to protect the territory, so that animals should not be captured there.
4. When the construction stage is over, it is necessary to monitor regularly populations of terrestrial animals in the existing research sites within the project territory.
5. The so-called ‘closed zones’ (protected with a fence) must be organized in the territory of the objects, where no activity should be allowed. It would serve both a buffer zone of the object and, at the same time, a kind of protected area where animals can live undisturbed.
6. The Russian tortoises must be removed from the construction site to nearby areas with similar biotopes. Moreover, after the removal, the site must be enclosed in a solid corrugated metal fence to prevent the tortoises’ possible returning to the construction site.

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Appendix 1

Fig. 1. Sagebrush association at VP-1

Fig. 2. Rocky outcrop at VP-12

Fig. 3. Sagebrush association and ruins at VP-10

Fig. 4. Examining ruins at VP-10

Fig. 5. Young individual of the Steppe agama at VP-8

Fig. 6. Turkestan thin-toed gecko in a rock crack at VP-2

Fig. 7. Sunwatcher toad-headed agama at VP-5

Fig. 8. Rapid lizard at VP-4

Fig. 9. Russian tortoise male courting a female

Fig. 10. Mating Russian tortoises

Fig. 11. Russian tortoise's egg

Fig. 12. Young individual (born previous year) of the Russian tortoise